

A Clinical study of the teeth in cleft palate.

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INTRODUCTION

Interest in the problems associated with cleft palate is increasing rapidly, and it is now common practice for a team of specialists to meet and jointly undertake the treatment of patients with cleft palate and the investigation of these anomalies. An important member of such a team is the dental surgeon, and it is essential that he investigate those abnormalities that relate to his own speciality.

The membership of such a team meeting as the Cleft Palate Clinic of the Royal Hospital for Sick Children, Edinburgh, gave me the stimulus and provided the opportunity for this study.

AIM OF STUDY

The first responsibility of the dental surgeon is for the patients teeth, and observations made at the Cleft Palate Clinic revealed many features relating to the teeth that required further investigation. This study was undertaken as an investigation into the abnormalities of number, form, and structure of the teeth in a group of children with cleft palate.

As a result of this study it was hoped that a more complete picture would emerge of the abnormalities of the teeth in children with cleft palate, including the relationship of such abnormalities with the development defects and environmental upsets found in these patients.

The study is not concerned with the skeletal and occlusal deformities which may frequently be associated with cleft palate.

MATERIAL FOR STUDY.

Patient study group

The material for this study is a detailed record of the deciduous and permanent teeth of 76 children with cleft palate. These children will be referred to as the patient study group.

Number, Sex, and Age of Patients

The total of 76 children was made up of 49 boys and 27 girls; the preponderance of males being in accord with the usual sex incidence (Schwartz 1954).

Since it was necessary to examine both the deciduous and the permanent teeth of each patient, the children were predominately aged from 4 to 6 years. After 6 years of age the deciduous incisors have been usually exfoliated, and 4 years of age is the minimum age at which co-operation can be expected. There were 55 children within this age-group in the sample.

In addition, 26 older children with cleft palate under orthodontic treatment at the Edinburgh Dental Hospital were included. Full records of the deciduous dentition of all these patients were available. The ages of the patients studied are given in Table I.

Table I.

Age in years	4	5	6	7	8	9	10
Number of patients	26	14	15	8	7	4	2

Mean age = 5.7 yr.

Modal age = 4 yr.

Source of Patients.

The subjects of this study were child patients from cleft palate record files of the Royal Hospital for Sick Children, Edinburgh, the Western General Hospital, Edinburgh, and the Bruntisfield Hospital for Women, Edinburgh. These hospitals are the centres for cleft palate surgery in the region of the South Eastern Regional Hospital Board, Scotland.

Adequacy of Patient Sample.

The population of the region covered by the South Eastern Regional Hospital Board of Scotland is given in the Hospital Year Book (1961) as 1,139,200. The birth-rate of Edinburgh is given by the Registrar General's Report (1959) as 17.4 per thousand. No local incidence study of cleft palate is available. The incidence of 1:1000 of cleft palate in the surviving population is given by Fogh-Anderson (1942) from his study in Denmark. With this figure an estimate can be made of 20 children born each year with a cleft palate in a population of the size of that in the South Eastern Regional Hospital Board available for study. Therefore, in the age-range of 4 - 6 years, of a theoretical potential of 60 children, 55 were examined. In virtue of the group being almost exclusively limited to children from a single region, it must be considered as necessarily a selected sample.

DENTAL EXAMINATION PROCEDURE :

Case History

The patient's age and sex was recorded together with any details of the operative history that could be obtained from the child's parents. The time of operative repair of lip and palate were obtained from the record file of the appropriate hospital, and the parents' information served as a useful check.

Clinical Examination

An examination of the mouth was made and the type of cleft determined. The erupted teeth were recorded, and if a tooth was absent the parents were asked if it had been extracted.

Examination for Enamel Hypoplasia

The surfaces of the standing teeth were examined with a mirror and dental probe in a good light. A single standard of recording hypoplasia was utilized corresponding to the definition 'gross' or 'textbook' hypoplasia (Mellanby and Mellanby 1948). This is described as being readily visible to the naked eye. The teeth so classed have obvious enamel pits or areas of defective enamel, and it is the form of defective structure of the teeth that is commonly described as enamel hypoplasia by dental surgeons.

Teeth which were so extensively attacked by dental caries that no examination of the surface structure could be made were not/...

/not classified as hypoplastic.

Dental Casts

An impression of the upper and lower dental arches of each child was taken in aliginate or Paribar dental impression materials. Dental casts from these impressions were studied to determine any abnormalities of the standing teeth.

Radiographic Examination

A radiographic examination of the jaws of each child was made, using intra-oral films for the incisor and canine regions and extra-oral oblique lateral jaw radiographs of the premolars and molar regions. It was possible to record the presence or absence of all the permanent teeth excepting the third molars, but only marked abnormalities of tooth form could be observed in the unerupted teeth. The radiographs aided the differentiation of alveolar from prealveolar clefts and enabled the relationship of the teeth to the alveolar cleft to be accurately determined.

SUPPLEMENTARY MATERIAL

Clinical

The membership of the Cleft Palate Clinic made available many interesting case records relevant to this study.

Clinical material comprising photographs, radiographs, or histological material was included if it was felt that it would usefully add to the subject matter.

Collection of Extracted Teeth

A collection of 14 incisor teeth extracted from the margin of alveolar clefts in patients under treatment was made. The group comprised 10 lateral incisors from the margins of alveolar clefts and 4 central incisors. A morphological examination was made of these teeth, histological ground sections prepared, and the findings incorporated into this study.

Parent Group

Parents who accompanied their children for the examination of the cleft study group were also subjected to a clinical dental examination. 85 parents were examined for abnormalities of tooth number, and radiographs were taken if such abnormalities were observed and not explained by a history of tooth extraction.

Control Groups

The observations made on the patient study group included studies on the abnormalities of tooth number and the incidence of enamel hypoplasia of the teeth. A high incidence of both defects were found and it was necessary to determine the general incidence of such defects in normal children to determine if the findings on the cleft study group were significant. The following control groups were therefore examined.

1. Control Group for Observations on Absence of Teeth.

The dental records of 100 children from the Harpenden Growth Study Group at the Royal Dental Hospital, London, were examined. The group examined were of a similar mean age to the cleft study group, and full details on the group and of the findings are given in the Appendix (P.120).

2. Control Group on Enamel Hypoplasia.

The teeth of 100 children from Stockbridge Primary School, Edinburgh, were examined for the presence of enamel hypoplasia. The details of the group and of the findings are given in the Appendix (P.122).

CLASSIFICATION AND ANALYSIS OF CLEFT PALATE IN PATIENT
STUDY GROUP

Classification

Cleft palate is a collective term used in this country to describe a number of cleft forms. A detailed classification is required to tabulate and compare the results of this study with previous work. The classification of Veau (1931) is often used by clinicians, but is inadequate for a dental investigation as the main emphasis is on palatal involvement, and the various degrees of cleft of the lip and dental area are inadequately differentiated.

A morphological classification in wide use at the present time is that of Davis and Ritchie (1922). In this classification clefts are divided into: Group I (prealveolar or lip clefts), Group II (postalveolar or palate clefts), and Group III (alveolar clefts). This classification is supported by Kilner (1958), who suggests its use as a basis for an international classification. It is particularly useful for a dental study as the relationship of the cleft to the alveolar part of the jaw is the basis of the classification and this is also an important relationship with regard to the dental irregularities found with cleft palate.

Incidence of Various Cleft Forms in the Patient Series

A total number of 76 children was examined and the cleft form recorded and shown in the individual patient records in the Appendix (Pp.151-165). No example of an alveolar cleft was present without an accompanying prealveolar cleft.

Also, no patients with bilateral prealveolar clefts, or a prealveolar cleft and a postalveolar cleft together without alveolar involvement, occurred in this series.

A postalveolar cleft with no other cleft form was present in 20 patients (No's. 6, 8, 12, 18, 20, 27, 28, 32, 33, 34, 44, 45, 50, 52, 58, 59, 61, 70, 72, 75). Twelve girls and 8 boys made up this group, the sex incidence here agreed with that found by Fogh-Anderson (1942) in this type of cleft, this being the reverse of the overall sex incidence in cleft palate.

Of the remaining patients 8 had prealveolar clefts (No's. 16, 21, 22, 35, 41, 46, 62, 68). In 4 of these patients the cleft form was unilateral, and was the only cleft form present, while in the remaining 4 patients the lip cleft was associated with an alveolar cleft of the other side.

A total of 52 patients showed an alveolar cleft. This group can be divided into 10 patients (No's. 11, 13, 14, 26, 48, 49, 53, 64, 65, 74) with a bilateral lip alveolar and palate/...

/palate clefts, and 31 patients (No's. 1, 2, 3, 5, 7, 9, 10, 15, 17, 23, 24, 30, 31, 36, 37, 38, 39, 40, 42, 43, 47, 51, 54, 55, 57, 60, 63, 67, 69, 73, 76) with a unilateral lip alveolar and palate cleft. A further 7 patients had unilateral alveolar clefts without involvement of the palate (No's. 4, 19, 25, 29, 56, 66, 71). Finally there were the 4 patients previously mentioned as having an alveolar cleft on one side and a prealveolar cleft on the other side.

The alveolar clefts totalled 62 examples when both sides of the bilateral forms are counted. When the prealveolar forms are added a sum of 70 cleft sides are present in the series, 36 on the left side and 34 on the right side, a somewhat lesser tendency to favour the left than the usual 3 : 2 proportion (Saunders, 1934).

Lip and Palate Surgery in Patient Series

The age favoured for lip repair by the surgeons undertaking this work in Edinburgh was 3 - 4 months. At this period the child is thriving and the soft tissue parts are well developed. In the group under study the mean age of lip repair was 4.7 months with 4 months as the modal value. The high mean value was caused by the late lip repair in a small number of children, and was due to various factors, such as throat infection, delaying the time of operation.

A similar pattern is shown with the age for palate repair/...

/repair. The mean age in the series was 20.4 months with a modal value of 18 months. The choice of this age for palate repair was determined by the surgeons clinical experience indicating that this was the most favourable age for the operation to produce a satisfactory speech result. The age of both lip and palate repair for the individual patients is given in the Appendix (Pp.151 - 165).

The form of surgical repair of the lip was generally based on the operation described by Le Mesurier (1949). However, in a number of older patients a simpler form of lip closure such as advocated by Kilner (1958) had been carried out. Bilateral lip clefts had been closed at a single operation, and the surgical opinion was against reduction or surgical repositioning of the premaxilla by resection of a portion of the nasal septum. Patients in which this procedure had been carried out were excluded from the series to avoid the possibility that this procedure had affected the dental findings.

The operative technique for closure of the palate was based on that of Wardill (1937). This is a three or four flap repair allowing a 'push back' procedure to lengthen the soft palate.

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EMBRYOLOGY OF CLEFT PALATE AND RELATED DENTAL ANOMALIES.

The human face is developed from the frontonasal, maxillary, and mandibular embryological processes. These are formed by the proliferation of the mesoderm at the third week, causing a bulging of the surface with production of a soft tissue process. A failure of growth or union between these soft-tissue processes in the embryo is the cause of the various forms of facial and oral cleft observed clinically.

The lower jaw is formed by the two mandibular processes merging by extension to eliminate the midline furrow (Patton, 1961). The upper jaw is formed by the fusion of extensions of the frontonasal process and maxillary processes. An epithelial wall is formed by contact of the frontonasal and maxillary processes, and it is necessary for this epithelial wall to be penetrated by the mesoderm to complete the process of fusion (Stark, 1954). It is generally held that the mesoderm of the maxillary process comes to overlay that of the frontonasal process, and Boyd (1933) produced evidence of this in a comparative study of the upper lip in mammals.

The fusion of the frontonasal and maxillary processes beneath the nasal pit is complete at 7 weeks and forms a structure known as the primary palate, separating the nasal and oral cavities (Stark, 1954). After formation of the primary palate, the palatal process of each maxillary process becomes prominent and from the eighth week fuse in the midline (Stark and Ehrmann, 1958) to form the hard and soft palate. From this sequence of events Kernahan and Stark (1958) have produced a further embryological classification of cleft palate. This describes the conditions of a primary palate cleft and a secondary palate cleft, the former consisting of clefts of the lip and alveolar process and the second consisting of clefts of the hard and soft palate. This classification is valuable in that it emphasizes that clefts of the dental area and of the lip are embryologically related defects, while the clefts of the palate are a separate entity; and for this distinction this terminology is utilized in this study.

The ossification centres of premaxilla and maxilla are formed in the mesoderm of the primary palate, but it is extremely difficult in the upper jaw to relate the boundaries of the facial processes to the position of the ossific centres (Dixon, 1958).

A dispute exists about the separate existence of a premaxilla in man. The opinion against a separate existence is held by Fraser (1940) and Jacobson (1955). The evidence for their opinion hinges mainly on whether the premaxillary ossific centre is considered as a separate ossific centre or an extension of the maxillary ossific centre in the particular embryos described. An incisor process has been described as growing forward from the maxilla and forming the labial plate of the premaxilla (Callender, 1869; Wood-Jones, 1950), but no sign of an interalveolar suture in the premaxilla was found by Chase (1942). Early views that the cleft could be related to the sutural system of the premaxilla (Goethe, 1831; Albrecht, 1879; Kolliker 1882), have been challenged by the work of Keith (1909), and Peter (1921), who have suggested that the defect is related to the fusion of the soft tissue processes previous to the formation of the maxillary and premaxillary bones.

The formation of the dental lamina in relationship to the embryology of clefts is discussed by Tondury (1961).

He states that the first dental anlage is seen at the 12 - 14 cm.CR stage in the form of a dental shelf, while the epithelial wall formed between the frontonasal and maxillary processes may be seen in embryos of 8 - 12 cm.CR.

The invasion of this epithelial wall by the mesoderm is immediate and it has disappeared by the 12 - 14 cm.CR stage.

This suggests that the formation of the dental lamina and of the tooth buds is after the period of formation of a cleft.

This suggestion is in conflict with an earlier opinion (Inouye, 1912), that the formation of a cleft could cause supernumerary tooth formation by the splitting of the lateral incisor tooth germ.

ARRANGEMENT OF FINDINGS

The study is divided into three sections which are each concerned with abnormalities requiring a different method of investigation and assessment. In each section a review of the literature is followed by a description of the findings in the patient study group and finally the findings are discussed and compared with those of previous studies.

Supplementary clinical and histological material is used to illustrate further the abnormalities found or to clarify points under discussion.

Section I of Study

This first section is a study of abnormalities of tooth number. First, the abnormalities at the vicinity of a cleft are described; these irregularities are mainly limited to patients with a lip or lip and alveolar cleft. An analysis of such abnormalities involves a consideration of the position of cleft relative to the teeth and the embryological implications of such a relationship. The abnormalities of tooth number found in the dentition away from the cleft site are separately described and discussed.

Section II of Study

This section is devoted to a study of tooth form in the cleft palate dentition. The considerable variations of form of the lateral incisor teeth in the margin of an alveolar cleft are described and classified. Abnormalities of tooth form that were observed in the rest of the dentition are also recorded and the possible causes of tooth malformation both in the vicinity of a cleft and elsewhere are discussed.

Section III of Study

The defective tooth structure present in many patients with cleft palate presents a severe problem from the treatment viewpoint. An investigation into the incidence of enamel hypoplasia of the teeth in the patient study group is undertaken and presented in this section, together with a discussion as to the possible causation of such a defect.

Illustrations

Many of the illustrations are referred to in more than one section of the study and they are therefore grouped together for convenience of reference, Pp. 95 - 120.

Summary and Conclusions

The findings of the three sections of the study are integrated and summarized, p.83.

Appendix

The following are placed in the appendix for ease of reference, and to improve the continuity of the main text:-

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SECTION I

ABNORMALITIES OF TOOTH NUMBER

L I T E R A T U R E

The anomalies of the incisors in the vicinity of a cleft have received considerable attention, and in the past two hundred years many of the most distinguished surgeons and anatomists have made contributions to this subject. The number of publications is so great, many of them consisting of single case reports or unsupported opinions, that it was necessary to select only the major studies to illustrate the main trends of thought.

The discoverer of the premaxilla in man, Goethe (1786) also suggested that a cleft would follow the premaxillary suture, thus separating the lateral incisor from the canine. That this was not an invariable finding was realized by Albrecht (1879; 1884). He studied the comparative anatomy of the premaxilla, especially in the horse, and reported that it was comprised of two bones, which he named the endognathion and mesognathion; the first supporting the central incisor and the second the lateral incisor. Since it was suggested that a cleft could be situated on either side of the mesognathion, a variable position of the lateral incisor was explained.

The Edinburgh surgeon William Ferguson (1867) wrote that the general arrangement was, 'the two front incisors are usually tolerable perfect, the additional incisor on each side is generally of imperfect development or altogether wanting'. A study by Turner (1885) presented 16 maxillary casts of cleft palate/...

/palate patients including some from the Edinburgh Dental Hospital, to support the views of Albrecht. However, a contrary view was expressed by Kolliker (1882) on the basis of a large study made from skulls, and dissections made by stripping back of the periosteum of specimens to show the positions of tooth germs. A total of 49 specimens from German museums was examined and Kolliker found almost equal numbers of instances of clefts situated on both the mesial side of the lateral incisor (23 instances) and the distal side of the lateral incisor (25). Six instances of absence of this tooth were observed, but from its usual form he maintained that its position was predominately on the premaxilla. The difficulty of explaining the presence of an extra tooth on the maxilla has been overcome by those maintaining this view by the use of the term 'pre-canine' supernumerary (Veau, 1926). An hypothesis that clefts could be caused by supernumerary tooth formation was put forward by Warnekros (1909), but no support has been given to this suggestion.

The relationship of the cleft to the teeth was examined by Keith (1909) on 41 specimens collected from English museums; he found the cleft to be situated between the central and lateral incisor in 21 instances, and between the lateral and canine in 9 cases. In 9 further cases, there was absence of the lateral incisor and in 2 cases a supernumerary lateral was present. Keith disagreed with Albrecht's conclusions and focused attention on the part played by the facial processes in the formation of a cleft. This concept was developed by Inouye (1911), Peter (1921), and Herbst and Apfelstaedt (1928) who considered/...

/considered that the development of the facial processes and the ossification of the bones were a separate process. Inouye suggested that the cleft initiated supernumerary tooth formation by splitting the developing lateral incisor tooth germ.

Recently Tondury (1955, 1961) has presented histological sections of early human embryos showing the developing lateral incisor tooth germ in close relationship to a cleft, and reported that the analage of the lateral incisor was most frequently found in the anterior segment. Robinow (1958) who re-examined one of the embryos described by Tondury and describes two further embryos suggests, however, that the lateral incisor is usually on the maxillary (posterior) segment. Two full term fetuses with bilateral alveolar clefts were examined with serial section technique by King (1954), and in each case the anterior segment contained four incisors. A suggestion made by Mathis (1935) is that supernumerary tooth formation could be caused by an extension of the dental lamina down the side of a cleft.

A diagrammatic presentation of the various hypotheses which have been made to explain the variations in incisor number and position relative to a cleft is given in Fig.1. The present concept is of the dental lamina differentiating into tooth germs after the cleft is established and is based on the observations of Tondury. Robinow considers, however, that if two lateral incisors were present, one medial and one distal to a cleft, they were at one time one tooth; in one embryo which he examined/...

/examined, two such teeth were present, and they were both smaller than usual. Therefore, some supporters of each theory exist, with the critical difference being the relative time of failure of fusion or breakdown of the epithelial wall, together with the time of tooth formation.

Early studies distinguished inadequately between the teeth of the deciduous and permanent dentitions. With the advent of dental radiology the presence of unerupted teeth can readily be demonstrated, and three studies on supernumerary teeth in cleft cases have been published using this aid. The largest group of patients investigated was reported by Milhon and Stafne(1941); they radiographed the upper incisors of 81 patients with clefts, 21 of these being cleft lip cases. In 7 instances there was absence of the second incisor, while supernumerary incisors were present in 1 of the cleft lip cases and 22 of the remainder.

A strict analysis was not undertaken, but a tendency for supernumerary deciduous lateral incisors to be followed by supernumerary permanent lateral incisors was noted. These anomalies were considered as due to the splitting of the tooth germ, and the opinion was expressed that the more severe the cleft the greater the tendency to form supernumerary teeth.

In a paper on the treatment of dental anomalies in cleft palate Harvold, (1947) discusses 41 patients. He found that all the teeth are usually present in the deciduous dentition, but absence of the permanent lateral occurred in approximately one half of these cases. The absence of a central incisor in a number of cases is commented on, as is the frequency of transpositions.

Bohn (1950), in an excellent paper, describes the anomalies in the deciduous and permanent lateral incisors of 63 children with clefts. In 52 of his patients dental casts were available and all the patients were radiographed, but his observations were limited to the lateral incisors. The group included 15 patients with postalveolar clefts with no abnormalities of the lateral incisor teeth. A further 15 patients with prealveolar clefts had supernumerary deciduous lateral incisors in about three-quarters of the cases, while in the permanent dentition supernumerary formation an absence of the lateral incisor was equally numerous. In the remaining 33 cases with alveolar clefts supernumerary deciduous lateral incisors were less common, while in 'about three-quarters of the cases the permanent laterals were absent'.

Although the problem of incisor anomalies in relationship to a cleft has received far more attention than any other aspect of the cleft palate dentition, a number of disputed points still remain as shown from this review of the literature. The examination of early human embryos when available is most valuable especially as a study of the stages of morphogenesis of tooth and cleft formation, but even here different interpretations of findings are possible. The radiological evidence is more complete, but further material would be valuable as a number of differences, including that of relationship of the degree of dental abnormality to the type of cleft, have been noted.

The confused situation on this subject is typified by the relevant observations in the current major dental pathology textbooks/...

/textbooks. Stones (1957) quotes mainly Kolliker's work of 1882 on tooth number and relationship to a cleft, this being given as almost equally between the central and lateral incisor and lateral incisor and canine; in the recent new edition of this textbook (1962) reference to Kolliker's work has been deleted and the subject is covered by the general statement 'When the primary palate is involved either with or without the secondary palate the second incisor may develop in different positions'. Thoma and Goldman (1960) state: 'In some cases the cleft is found between the second incisor and canine and in isolated cases posterior to the canine'.

The literature contains a number of references to other abnormalities of tooth number in patients with cleft palate apart from those occurring in immediate relationship with a cleft. Cooper (1946) reports a case of anodontia in the permanent dentition in a child with a cleft lip and palate. Also, since the start of this study the absence of premolar teeth have been the subject of two reports from the U.S.A. Castaldi (1958) examined 155 children with lip and palate clefts for this abnormality and found one or more premolars to be absent in 16 per cent of the children. The second study was reported by Olin (1960), and of 105 patients with clefts 29 showed absence of one or more premolars, giving an incidence of approximately 20 per cent. He also noted absence of upper permanent lateral incisors in 4 of the 23 patients in the group with clefts limited to the palate.

ANALYSIS OF FINDINGS

The observations made on tooth number in the patient series examined were divided into two groups. The first group comprises observations on the upper incisors and canines adjacent to a cleft which, by its presence, might be the cause of dental abnormalities. The second group contains the observations made on the remainder of the dentition not directly affected by the situation of the cleft.

Abnormalities of Tooth Number adjacent to a Cleft

It was found that the variations of tooth number and the variations of possible relationships of these teeth with a cleft could be analysed in both deciduous and permanent dentitions within the six variants shown in Fig.2. It was therefore considered that a clearer picture would emerge if initially these features were considered together, and then followed by a separate analysis of each feature.

A normal tooth number was present with three cleft relationships:-

1. With a prealveolar cleft (Fig.2, Variant A).
2. With an alveolar cleft separating the central from the lateral incisor (Fig.2, Variant B).
3. With an alveolar cleft separating the lateral incisor from the canine (Fig.2, Variant C).

A supernumerary tooth was present with the following forms of cleft:-

4. With a prealveolar cleft (Fig.2, Variant C).
5. With an alveolar cleft separating the lateral incisor from the supernumerary (Fig.2, Variant E).

Absence of the lateral incisor also occurred;

6. With an alveolar cleft separating the central incisor from the canine (Fig.2, Variant F).

No examples of the other possible relationships were found in this study excepting two instances of absence of upper permanent incisors which were observed in patients with postalveolar clefts. These are omitted from the analysis to clarify the presentation at this stage by limiting it to clefts of the primary palate.

The above tooth/cleft variants were observed in the 56 patients with clefts of the lip or of the lip and alveolus. Of this group of 56, there were 14 patients with bilateral lip or lip and alveolar clefts. Therefore, this group provided 70 cleft sides for investigation which were first considered as a single group but later analysed to determine if the form, side, and extent of a cleft influenced the dental abnormality.

The incidence of each variant found in the patient study group is given in Table II.

Table II

Dental Variant (Fig.2)	A	B	C	D	E	F	Total
No. occurring in deciduous Dentition	4	38	2	4	14	8	70
No. occurring in permanent Dentition	4	27	2	4	9	24	70

From this table it may be seen that the most frequent position of an alveolar cleft was to separate the ~~lateral~~ lateral incisor from the canine, and this occurred in 38 instances (54 per cent) in the deciduous dentition and in 27 instances (39 per cent) in the permanent dentition. It is notable that the cleft separated the lateral incisor from the canine in only 2 instances in both dentitions.

When the abnormalities of number of the teeth adjacent to clefts were further analysed the following table (Table III) could be constructed.

Table III

Tooth Number	Normal	Supernumerary Lateral Incisor	Absence of Lateral Incisor	Total
Deciduous Teeth	44	18	8	70
Permanent Teeth	33	13	24	70

In the deciduous dentition of this group of patients supernumerary tooth formation in the region of a cleft was frequent, but relatively uncommon in the permanent dentition. The reverse is true of instances of absence of the lateral incisor which commonly occurred in the permanent dentition, but not in the deciduous dentition.

It was possible with the material available to examine both the deciduous and permanent teeth of each patient. Therefore the relationship of the dental variants in the deciduous dentition to the succeeding variants in the permanent dentition could be established, and these are given in Table IV

Table IV

Dental Variant	No. found in Deciduous Dentition	Succeeding Variant in Permanent Dentition	No. found of each Succeeding Variant
A	4	A D	3 1
B	38	B E F	21 2 15
C	2	F	2
D	4	A D	1 3
E	14	B C E F	3 2 6 3
F	8	B F	3 5

The general tendency was for the variant in the deciduous dentition to be followed by either the same variant in the permanent dentition or one with fewer teeth. Thus of the 18 patients with supernumerary laterals in the deciduous dentition (variants D and E), 9 had a supernumerary lateral in the permanent dentition, while 6 had a normal tooth number and 3 had absence of the permanent lateral incisor. Of the 44 patients with a normal tooth number (variants A, B, and C) 17 showed absence of the permanent lateral incisor. There were in contrast 6 instances when a permanent lateral incisor was present without the presence of a preceding deciduous lateral incisor on the same side of the cleft.

The most frequent variation of cleft position in the deciduous dentition was the cleft to separate the central incisor from the lateral incisor. This was often followed in the same patient by a similar arrangement in the permanent dentition. In the ~~deciduous~~ dentition the only two instances of the cleft being placed between the lateral incisor and canine were followed by the same arrangement in the permanent dentition.

A further point that required investigation was the possible effect of the extent of the cleft on the dental abnormality. To examine this feature Table V was constructed with the 56 patients exhibiting clefts involving the primary palate.

Table V

Cleft Type	Patients	Deciduous Dentition		Permanent Dentition	
		Variants	Number	Variants	Number
Prealveolar	8	A D	4 4	A D	4 4
Lip and alveolar	7	B E	6 1	B E F	3 1 3
Lip, alveolar, and palate	55	B C E F	22 2 13 8	B C E F	24 2 8 21

The group of patients with a palate cleft associated with a lip and alveolar cleft showed a similar range of abnormalities to the group with a lip and alveolar cleft, and therefore in this series this association did not affect the dental variant produced. The group of patients with lip clefts was distinguished from the remainder, as in both dentitions one-half of the patients had supernumerary lateral incisors. The 20 patients with postalveolar clefts included 2 instances of absence of a permanent lateral incisor.

If the type of dental variant is related to the side of the cleft (Table VI) no significant difference is noted in position of cleft to the teeth, with abnormalities of tooth number.

Table VI

Dental Variant	Deciduous Dentition		Permanent Dentition	
	Right	Left	Right	Left
A	2	2	3	1
B	20	18	15	8
C	2	-	1	1
D	3	-	2	2
E	6	8	3	6
F	4	4	12	12

Similarly, if the dental variant is related to the patient's sex no significant relationship can be demonstrated (Table VII) when allowance is made for the predominance of male patients (40 male; 16 female).

Table VII

Dental Variant	Deciduous Dentition		Permanent Dentition	
	Male	Female	Male	Female
A	4	-	4	-
B	28	10	23	4
C	2	-	-	2
D	4	-	4	-
E	10	4	7	2
F	6	2	16	8

Abnormalities of Tooth Number apart from the Vicinity
of a Cleft

The material for this study enabled observations to be made on all the teeth of the patient study group, including those away from the vicinity of the cleft. Included, were the incisors and canines of both dentitions of the 76 patients examined, except the teeth related to the 70 cleft sides present in this group. An examination could also be made of the deciduous molars, the premolars, and permanent molars of all the 76 patients.

No abnormalities of tooth number in the deciduous dentition were observed which could be attributed to congenital absence of a tooth, but the high incidence of extracted deciduous teeth made this difficult to ascertain. In the permanent dentition the following instances of absence of teeth were observed in the labial segments unaffected by a cleft (Table VIII)

Table VIII

Upper Teeth	3/	2/	1/	<u>1</u>	<u>2</u>	<u>3</u>
No. absent	-	2	-	-	2	-
Lower Teeth	<u>3</u>	<u>2</u>	<u>1</u>	<u>1</u>	<u>2</u>	<u>3</u>
No. absent	-	-	-	-	1	-

Of the 4 upper permanent lateral incisors absent, 2 were involving patients with a unilateral cleft of the opposite side (Patient Record Nos. 7, 19) and 2 were missing from a patient with a postalveolar cleft who also showed absence of 2 second premolars (Patient Record No. 44). The single example of absence of a lower incisor was seen in a patient with a lip cleft (Patient Record No. 41).

Examination of the teeth in the buccal segments revealed that premolar teeth were absent in 20 of the 76 patients, and this condition is illustrated in Fig.3. Altogether 48 premolars were absent, 28 from the lower arch and 20 from the upper arch, and an analysis of the absence of individual teeth is given in Table IX

Table IX

Upper Teeth	<u>7/</u>	<u>6/</u>	<u>5/</u>	<u>4/</u>	<u>4/</u>	<u>5/</u>	<u>6/</u>	<u>7/</u>
No. Absent	-	-	11	1	-	9	-	-
Instances of Deciduous Molar Loss	+	+	-	-	-	1	+	+
Lower Teeth	<u>7/</u>	<u>6/</u>	<u>5/</u>	<u>4/</u>	<u>4/</u>	<u>5/</u>	<u>6/</u>	<u>7/</u>
No. Absent	-	-	13	1	1	12	-	-
Instances of Deciduous Molar Loss	+	+	3	-	-	4	+	+

The patients showing absence of premolars were the following: Patient Record Nos. 3, 5, 15, 27, 28, 32, 36, 41, 45, 48, 50, 51, 53, 61, 67, 68, 69, 70, 71, 72. Of these 20 patients 11 were male and 9 were female, showing that no relationship of this condition to sex could be established.

Absence of premolar teeth occurred in patients with different types of cleft, but Table X shows that it was especially marked in this series, in the group of 20 patients with postalveolar clefts.

Table X

Type of Cleft	No.of Patients	No.showing Absence of Teeth
Prealveolar	8	3
Lip and alveolar	7	1
Lip, alveolar and palate	41	10
Postalveolar	20	9

A number of other abnormalities were noted in the patient series. First, the presence of 2 upper midline supernumerary teeth (Patient Record Nos.29, 49) should be recorded. It is convenient to record in this section also, the finding of 4 instances of delayed calcification of teeth. The first 3 instances were of lower permanent molars (Patient Record Nos. 13, 45, 47) and the third was of an upper central incisor on the side of the lip cleft in a patient with a bilateral lip left alveolar palate cleft (Patient Record No.16). In Fig.4 are illustrated several of the abnormalities.

DISCUSSION

In this study the most common relationship found of the cleft to the teeth of both dentitions, was for the cleft to separate the central from the lateral incisor, while the least common position for the cleft was between the lateral incisor and the canine. These findings correspond most closely with those described by Keith (1909), but the instances of separation of the second incisor from the canine are even more infrequent than he found. This is of considerable importance as Goethe's hypothesis (1831), and to some extent Albrecht's hypothesis (1884), on the relationship of clefts to the formation of the premaxilla are both dependent on the incidence of cleft position to the lateral incisor. If a cleft position between the lateral incisor and canine is an uncommon finding neither of these hypotheses is satisfactory. A possible explanation of the discrepancy of the findings between this study and those of earlier studies is that many of the cases classified here under variant E (Fig.2) would previously have been described as a cleft between the second incisor and canine with the presence of a precanine supernumerary.

The study also shows that in the region of the cleft supernumerary incisors are common in the deciduous dentition (24.6 per cent) and the absence of lateral incisors in the permanent dentition (34.4 per cent). This follows the findings of Bohn (1950) in his group of patients, but with a lesser incidence of abnormalities than he found. Absence of lateral incisors/...

/lateral incisors, especially in the permanent dentition, was shown most frequently with alveolar clefts, while supernumerary incisors commonly occurred in both dentitions with lip clefts. This latter finding is not in accordance with the suggestion by Mathis (1935) that the dental lamina may extend with a cleft, and thus form supernumerary teeth. However, a tendency was manifest for the tooth/cleft relationship in the deciduous dentition to be followed by the same arrangement in the permanent dentition, indicating that each part of the separated dental lamina retains its normal potential to form tooth germs of each dentition.

A statement of Millhon and Stafne (1941) that can be supported is that when supernumerary deciduous incisors are present there is a tendency for the production of supernumerary permanent incisors. This occurred in 13 out of the possible 18 instances in this study, and when a supernumerary tooth was present the cleft separated it from the lateral incisor. No instance of transposition of teeth, or of absence of the central incisor was found to support Harvold's (1941) findings, except that one instance of retarded calcification of a permanent central incisor was present.

It is important to note that in 8 instances absence of the deciduous lateral incisor occurred, and this does not appear to be in complete agreement with Harvold's statement that the deciduous dentition is usually complete. In 3 of the 8 instances of absence of a deciduous lateral a succeeding permanent lateral incisor was present. This also was apparent/...

/apparent in 2 further instances in this series when a supernumerary permanent lateral was not preceded by a supernumerary deciduous lateral incisor.

An interesting explanation of the appearance of a permanent incisor without a preceding deciduous tooth is early shedding of tooth germs. This was mentioned by Veau (1933) who suggested that it occurred owing to insufficient bony support. This condition has been observed in babies seen at the Cleft Palate Clinic at the Sick Children's Hospital, Edinburgh, and was recorded in 5 out of 25 babies seen in the first week after birth. An instance is shown in Fig.5 on the mesial aspect of an alveolar cleft, a site common to 4 of the 5 instances found, while in only 1 instance was it observed on the distal side of a cleft. This anomaly helps to account for the relatively few instances of absence of the lateral incisor in the formed deciduous dentition in the patient series. However, the many examples of absence of permanent lateral incisors cannot be explained in this manner, especially as the permanent lateral tooth germ does not start to form until the tenth month (Scott and Symons, 1958).

The findings of this study on the remainder of the dentition confirm Castaldi's (1958) findings on the tendency to absence of premolar teeth. The incidence of 26 per cent in this series is even more marked than the 16 per cent he reports and the 20 per cent of Olin's (1960) group. There are several factors which may explain the extremely high incidence found in this series of patients. First, it is known that one complication of extraction of deciduous molars is the occasional removal of the underlying premolar (Archer, 1956). There were 8 instances of premature removal of the overlying deciduous molar in the 48 instances of absence of a premolar in this series (Table IX).

The possibility therefore exists that in some of these instances the absence of a premolar could have been caused by its extraction with the overlying deciduous molar, although no history of this was obtained in any of these cases. Secondly, the youngest children in the patient series were of 4 years of age. The start of calcification of the premolar teeth is given by Scott and Symons as $1\frac{1}{2}$ - $2\frac{1}{2}$ years: however, from personal experience it is known that an occasional example of late formation of premolars, especially lower second premolars, may be encountered.

To counter the possibility that these factors may have influenced the findings on congenital absence of premolars the control/...

/control group of children was examined and is described in the Introduction P.11 and the findings are detailed in the Appendix, P.120. In this control group of similar age to the cleft study group, an incidence of 6 per cent of apparent absence of premolars was found. When compared with the 26 per cent in the group of children with cleft palate a statistically significant value can be obtained for congenital absence of premolars in cleft palate (Appendix, P.126).

It is interesting to note that of the 48 absent premolars in this series 45 were second premolars and 3 were first premolars. Also, there were absent 4 permanent upper lateral incisors and 1 lower lateral incisor not involved in a cleft (Table VIII). This pattern is similar to that shown by Clayton (1956) when he examined 3557 normal children radiographically. This suggests that the absence of premolar teeth in cleft palate is a feature of the condition of partial anodontia and not a local anomaly. In partial anodontia the permanent dentition is more frequently affected than the deciduous dentition (Stones, 1957). Any reduction in the developmental potential of the permanent lateral incisor, which is commonly affected in partial anodontia, may severely reduce the possibility of formation of the tooth in the adverse environment of a cleft. This may explain to some extent the tendency for absence of the permanent lateral incisors in alveolar clefts.

SECTION II

ABNORMALITIES of TOOTH FORM

L I T E R A T U R E

This aspect of the cleft palate dentition has received remarkably little attention considering the possible significance of such abnormalities to the general problem of tooth malformation. Reference to abnormalities of tooth form is usually limited to general statements that 'the lateral incisor may have an irregular form'. Harvold (1947) Bolk (1917) mentioned also that supernumerary teeth associated with clefts may be tuberculated.

An exception, is the study of the lateral incisor in the cleft palate by Bohn (1950). He noted the frequency of conical forms in the permanent dentition and commented on the occurrence of a characteristic form in the deciduous dentition which he called the 'T' form. He described it as an incisor with a pronounced 'tuberculum dentis', the point of which is attached to the incisal edge by a 'crista'. He found this form in 10 per cent of all deciduous laterals limited to the left side, and suggested it might be a tooth form limited to cleft palate and either inherited or caused by development of the tooth in the abnormal environment of a cleft. He did not describe fully the variations of this 'T' form, or of the other abnormalities of tooth form found, but did record the appearance of a supernumerary with a caniniform appearance on the distal aspect of a cleft.

Abnormalities of size and form of lateral incisors developing adjacent to a cleft were reported by Robinow (1958), who presented sections of a human embryo showing tooth germs developing in this situation which were reduced in size.

The possibility that abnormalities of form may occur in the cleft palate dentition apart from the region of the cleft has attracted little attention. Kirkham (1931) considered that there was no reason why the rest of the dentition should be abnormal, but Schulze (1953), in an article on tooth abnormalities, illustrated a geminated deciduous molar in a child with cleft palate.

ANALYSIS of FINDINGS

The findings of this section are divided into two parts as in the first section of the study. The first part is a morphological study of the lateral incisor in the margin of a cleft. The material for this analysis consists of a study of the dental casts and radiographs of the patient study group, and also a review of the findings on a collection of extracted lateral incisors from the margins of alveolar clefts. The second part of the analysis concerns the abnormalities of morphology found in the remainder of the dentition in the patients studied. A description of the terminology and classifications of tooth morphology used is given together with the analysis of the findings.

✓ Morphology of the Lateral Incisors in a Cleft Margin

As the review of the literature showed, the morphology of this tooth is of considerable interest. Teeth in this situation are variously described as 'supernumerary', 'precanines', or 'lateral incisors', depending on their number form and situation. Such teeth appear to be formed from the portion of the dental lamina normally producing a lateral incisor, as both the central incisor and canine are usually present. Since it is not always possible to determine which of two teeth is the supernumerary all teeth in this situation will be termed lateral incisors. Lateral incisors of the deciduous and permanent dentition on the mesial margin of a cleft will be denoted/...

/denoted as bM and 2M respectively, and on the distal margin of a cleft as bD and 2D.

A classification of the abnormalities of form of supernumerary incisor teeth is given by Colyer and Sprawson (1937) and Stones (1957). Tooth form is described as:

(1) Normal or Incisiform (2) Abnormal. The abnormal forms are divided into (a) Conical, and (b) Tuberculate.

In the patient study group there were 79 deciduous lateral incisors and 59 permanent lateral incisors associated with the 70 cleft sides of the patient series. With the 8 clefts of the lip there were 12 lateral incisors available in both dentitions, and with the remaining 62 alveolar clefts there were 67 deciduous and 47 permanent lateral incisors. These teeth could be classified according to their morphology as in Table XI

Table XI

Morphology of Lateral Incisor	Normal (Incisiform)	Conical	Tuberculate	Total No.
No. deciduous	66	-	13	79
No. permanent	27	28	4	59

A marked contrast was observed in the form of these lateral incisors in the deciduous and the permanent dentitions. The majority of the lateral incisors of the deciduous dentition are normal in form, with also approximately one-fifth having a tuberculate form. The permanent lateral incisors are approximately/...

/approximately equally divided between normal and conical form, with only a small number of the tuberculate type seen.

The tuberculate teeth showed considerable variation in form and it was considered worthwhile to attempt a more detailed analysis.

A classification of tooth form found in the premaxilla was given by Colyer (1926) and is also used in this study.

- Group I, Conical shaped tooth.
- Group II, Conical shape with cusp on the mesial aspect.
- Group III, Additional cusp appears on the distal aspect.
- Group IV, Ridge formation on the palatal aspect from the base of the tooth to the distal aspect of the median cusp on the occlusal margin.
- Group V, The occlusal surface has assumed a tuberculate appearance, but is still divided by a palatal ridge.
- Group VI, Occlusal surface is more or less triangular enclosing a depression of varying depth.
- Group VII, Teeth showing a tendency to development of cusps from either the cingulum or the labial aspect.
- Group VIII, Complex tooth forms.

Group I and Group II abnormalities were classified together under Group I because of the difficulty in distinguishing a single minor cusp formation, especially on radiological examination. A selection of the abnormal lateral incisor tooth forms is shown in Figs.6 and 7, and serve to illustrate the above classification.

The number of patients exhibiting abnormally formed lateral incisors in the deciduous dentition was 13 (Patient Record/...

/Record Nos. 7, 11, 16, 21, 36, 43, 45, 47, 60, 62, 63, 66, 68), while in the permanent dentition 22 patients (Patient Record Nos. 1, 2, 4, 5, 7, 13, 14, 16, 22, 24, 30, 36, 41, 47, 48, 53, 55, 62, 63, 68, 74, 76) showed abnormal forms of one or more lateral incisors. The classification of Colyer was applied to the 13 deciduous and 32 permanent laterals of abnormal form (Table XII).

Table XII

Colyer Group	<u>I</u>	<u>II</u>	<u>III</u>	<u>IV</u>	<u>V</u>	<u>VI</u>	<u>VII</u>	<u>VIII</u>	Total
Deciduous Teeth	-	-	5	6	1	-	1	-	13
Permanent Teeth	28	-	2	-	-	2	-	-	32

The majority of the deciduous lateral incisors of abnormal form are in the Groups III and IV. The permanent lateral incisors are almost entirely limited to the conical type, with the four exceptions equally divided between Groups III and VI.

This grouping of teeth made it possible to analyse the abnormalities of morphology of these laterals in respect to various other features which might be considered as potentially having some influence on these findings. The analysis was made of the tooth morphology with regard to whether the cleft was left or right sided, the type of cleft, and also whether the lateral incisor was positioned on the distal or mesial aspect of the/...

/the cleft. These features were related to the morphology of the deciduous lateral incisors in Table XIII.

Table XIII

Classification of Tooth Form	Side of Cleft		Cleft Type		Relationship of Cleft	
	Right	Left	Prealveolar	Alveolar	Mesial	Distal
Group <u>I</u>	-	-	-	-	-	-
<u>II</u>	-	-	-	-	-	-
<u>III</u>	4	1	1	4	2	3
<u>IV</u>	3	2	3	2	-	2
<u>V</u>	1	1	-	2	1	1
<u>VI</u>	-	-	-	-	-	-
<u>VII</u>	1	-	-	1	1	-
<u>VIII</u>	-	-	-	-	-	-
Totals	9	4	4	9	4	6



In the deciduous dentition no significant difference in the distribution of the abnormal morphological forms in left-sided clefts was found when compared with right-sided clefts.

The type of the cleft appeared to have little influence on the types of abnormal tooth morphology, since Group III and IV forms were found in both prealveolar and alveolar clefts. If the difference in number of lateral incisors available for analysis is considered, i.e., 12 laterals associated with lip clefts, and 67 laterals with alveolar clefts, a relatively higher number of abnormally formed laterals is apparent with the lip cleft.

Only 10 deciduous lateral incisors of abnormal form were available for classification as to the relationship to the cleft. No significant difference in tooth morphology when related to relationship to the cleft could be demonstrated.

A similar analysis was undertaken with the lateral incisors of abnormal form in the permanent dentition. This is given in Table XIV.

Table XIV

Classification of Tooth Form	Side of Cleft		Cleft Type		Relationship to Cleft	
	Right	Left	Prealveolar	Alveolar	Mesial	Distal
Group <u>I</u>	17	12	6	23	3	24
<u>II</u>	-	-	-	-	-	-
<u>III</u>	-	1	-	1	1	-
<u>IV</u>	-	-	-	-	-	-
<u>V</u>	-	-	-	-	-	-
<u>VI</u>	1	1	1	1	-	2
<u>VII</u>	-	-	-	-	-	-
<u>VIII</u>	-	-	-	-	-	-
Totals	18	14	7	25	4	26

The vast predominance of conical forms of permanent lateral incisors made comparison of variations in form of these teeth in respect of the above features difficult. No apparent difference in tooth morphology could be observed in respect of side of cleft or cleft type. There were two permanent lateral incisors/...

/incisors (Patient Record Nos. 16 and 41) found with lip clefts that could not be classified as to cleft relationship.

It was noted also on close examination of the lateral incisors of both dentitions that have been classified as normal forms, that certain consistent incisor variations were present. These could be best described as a tendency for the lateral incisor to resemble in some degree the adjacent central incisor or adjacent canine in form. In those teeth with a tendency to resemble central incisors, the incisal edge did not slope distally so markedly as in the typical lateral incisor form, and the mesial and distal surfaces were less convergent. With the caniniform variety of tooth the incisal surface was divided into a mesial and distal slope and the crown was of a more bulky form than is typical of a lateral incisor. These variations are consistent with the tooth still being accepted within the normal range of variation (Wheeler, 1958), but to ascertain whether these modifications were a consistent finding in the patient series study they were analysed as subdivisions of the normal morphology.

There were 15 of the 66 normal deciduous lateral incisors that showed these modifications of form, and 3 of the 27 normal permanent lateral incisors. Examples of degrees of this tendency are illustrated in Fig.7. In Table XV these modifications are analysed in relation to side of cleft, type of cleft, and the tooth's relationship to the cleft margin.

Table XV

Modifications of lateral Incisor Form	Total No.	Side of Cleft		Cleft Type		Relationship to Cleft	
		Right	Left	Prealveolar	Alveolar	Mesial	Distal
Deciduous Teeth							
Central form	10	6	4	2	8	10	-
Caniniform	5	4	1	1	4	-	5
Permanent Teeth							
Central form	3	-	3	-	3	3	-
Caniniform	-	-	-	-	-	-	-

No relationship to side of cleft or cleft type is shown in the deciduous series, but the limited number of three permanent lateral incisors of abnormal form are all with left sided alveolar clefts. In both the deciduous and permanent dentition the lateral incisors with a 'caniniform' tendency are all on the distal side of the alveolar cleft, and the deciduous lateral incisors with a 'central form' are all on the mesial cleft surface.

Morphological Abnormalities in Ten Extracted Lateral Incisors

During the period of this study a collection of 10 lateral incisors was made. These teeth had been extracted from the margins of a cleft to enable the insertion of an orthodontic or prosthetic appliance. A morphological analysis was made of these 10 teeth, comprising 6 deciduous lateral incisors and 4 permanent lateral incisors. Photographs of each tooth were taken and are illustrated (Fig's. 8 - 17) to show the range of tooth forms found in cleft margins. A ground histological section was also made of these teeth and illustrated if the histology showed features of interest.

A number of abnormal morphological forms were present in these 10 teeth. Of the 4 permanent lateral incisors, 1 resembled a deformed central incisor, 1 was conical in form and 2 were tuberculate. Of these 4 permanent incisors, 2 presented with forms of minor enamel invaginations. In the group of 6 deciduous lateral incisors, 2 were of a tuberculate appearance which could also be classified as Colyer Group IV forms. One tooth was of a bilobed appearance, and the remaining 3 were essentially normal, although 2 showed some features of a canine.

A summary of the findings is presented in Table XVI, and a full description of each tooth is given in the Appendix (Pp. 132 - 139).

Table XVI

Specimen	Origin	Classification of Form	Summary of Observations
1 (Fig.8)	<u>/2M</u>	Incisiform	A twisted tooth with size and form of a central incisor. Hypoplasia of enamel and dentine of crown
2 (Fig.9)	<u>/2D</u>	Tuberculate Colyer Group <u>VI</u>	Multiple cone with deep central pit and well-developed cingulum
3 (Fig.10)	<u>2M/</u>	Conical Colyer Group <u>I</u>	Cone-shaped with pit Section shows small enamel invagination
4 (Fig.11)	<u>2D/</u>	Tuberculate Colyer Group <u>VI</u>	Blunted cone with high cingulum and enamel invagination
5 (Fig.12)	<u>/2D</u>	Incisiform	Rounded tooth with enamel hypoplasia and pit on lingual surface. Tendency to resemble canine

Table XVI (cont.)

Specimen	Origin	Classification of Tooth form	Summary of Observations
6 (Fig.13)	<u>/bD</u>	Tuberculate Colyer Group <u>IV</u>	Large cingulum with median ridge rising to raised central point on incisal edge. Severe enamel hypoplasia and some surface cones
7 (Fig.14)	<u>/bD</u>	Tuberculate Colyer Group <u>II</u>	Bi-lobed form with pit on lingual surface. Enamel hypoplasia
8 (Fig.15)	<u>/2D</u>	Incisiform	Relatively normal lateral incisor with enamel hypoplasia
9 (Fig.16)	<u>/bD</u>	Incisiform	Tooth with slight median palatal ridge suggesting a tendency to a Colyer Group <u>IV</u> type. Enamel hypoplasia
10 (Fig.17)	<u>/bD</u>	Incisiform	Bulbous crown form; morphology suggestive of canine

Abnormalities of Tooth Form in the Dentition
apart from the Vicinity of a Cleft

The radiographs and dental casts taken of each patient were studied for abnormalities of morphology of the remainder of the dentition. Few morphological abnormalities were found in the deciduous molars, and the only finding of note was 2 examples of paramolar cusp formation on first deciduous molars (Patient Record Nos. 5, and 67). In the permanent molars and premolars no abnormalities of form were observed.

Also examined were incisors and canines away from the vicinity of a cleft. There were 3 abnormalities of tooth form observed in the deciduous dentition and 5 in the permanent dentition; these are recorded in Table XVII and include examples of tooth gemination and dichotomy.

The terms gemination and dichotomy are used within the definitions given to these terms by Stones (1957). He described dichotomy as partial or complete division of a tooth germ, while gemination is the fusion of two tooth germs. In the present study when the adjacent teeth of the normal series are present the condition is referred to as dichotomy and if one is absent as gemination.

Table XVII

Dentition	Abnormality of Form	Cleft Type	Patient Record No.
Deciduous	<u>/A</u> dichotomy	Rt. lip alveolar palate	17
	<u>b/</u> tuberculate Group <u>IV</u> form	Postalveolar	45
	<u>BA/</u> geminated	Rt. lip alveolar	46
Permanent	<u>/2</u> conical	Rt. lip alveolar	4
	<u>1/</u> dichotomy	Lt. lip alveolar	15
	<u>2/</u> conical	Postalveolar	18
	<u>/2</u> dens invaginatus	Rt. lip alveolar palate	29
	<u>/2</u> dens invaginatus	Rt. lip alveolar palate	39

In the 40 patients with unilateral cleft Table XVII reveals that 1 geminated deciduous central incisor, 1 dichotomous permanent incisor (Fig. 4D) and 2 instances of lateral incisors with dens invaginatus were present in the incisor teeth of the normal side. With postalveolar clefts there was 1 instance of a tuberculate deciduous lateral incisor and 1 conical permanent incisor present (Fig. 4B). The only abnormality of form of the lower incisors of both dentitions was a gemination of a lower lateral and a central deciduous incisor.

DISCUSSION

A study of the morphology of the teeth that have formed in relationship to a cleft may have considerable value in providing some information on the factors which can influence tooth form.

In this study it was found that the abnormalities of lateral incisor form in the deciduous dentition were mainly of the tuberculate type, while in the permanent dentition a conical form was common. In this respect this study confirms that of Bohn (1950) and the statement of Bolk (1917) on the deciduous teeth. Analysis of the abnormal forms of lateral incisors found in the patient study group with the classification of Colyer revealed that the majority of the abnormal deciduous lateral incisors could be classified under Groups III and IV. Within these two groups the tooth form varied from a near normal appearance to a complex form (Table XII). Some of these forms, especially of the Colyer Group IV type, came within the description given by Bohn for his 'T' forms, however the findings of this study did not support his suggestion that this was a specific form characteristic of cleft palate. Further, De Jonge (1954) has described this type of tooth form in non-cleft individuals, but considers them rare, while a single example of a deciduous upper lateral incisor of this type in a normal patient was reported by Beresford (1953).

In this study the abnormalities of deciduous lateral incisor form were almost equally divided between clefts of the left and right sides, unlike Bohn's study where the 'T' form/...

/form laterals were present only on the left side.

The deciduous lateral incisor abnormalities were also found on either side of the cleft and were more common in lip clefts than lip and alveolar clefts in this series. In none of the instances of Group IV abnormalities in lateral incisors associated with prealveolar clefts was a supernumerary lateral incisor tooth also found, although supernumerary deciduous lateral incisors were found with 4 of the 12 prealveolar clefts. This is interesting, as Mathis (1935) considers that hyperplasia of the lingual cingulum is one method of production of a supernumerary tooth, and illustrated a tooth appearing to form a supernumerary incisor by separation of the lingual cingulum.

In the permanent dentition the abnormal forms were mainly conical, but also found were 4 instances of dens invaginatus (Patient Record Nos. 14 (2), 16, 62) and 2 further examples occurred in the collection of extracted lateral incisors from the cleft margin. The significance of this is obscure, but it is interesting to note that Colyer and Sprawson (1937) suggest that this anomaly could be an uncoordinated attempt by the enamel organ to divide, but Hallett (1953) does not support this view.

The possibility that teeth of abnormal form may result from development in an unfavourable environment has received attention from Euler (1939) and Hitchin and Ferguson (1958), who have described 'compression' forms caused by developmental crowding. However, the types of crown forms of the lateral incisors/...

/incisors in this series followed a pattern and enabled a classification to be used; and this suggested that well-defined abnormalities, such as conical permanent incisors and tuberculate forms of deciduous incisor, may be inherent in the tooth germ. The work of Glasstone (1952) is relevant as she showed that the morphology of rat molars is determined at an early stage, as demonstrated by the division of a molar tooth germ to form two small molars of normal crown form. The lateral incisor illustrated in Fig.5 which was exfoliated soon after birth from an alveolar cleft had an abnormal crown form at this early stage. The twisting of teeth, however, as seen in the incisor shown in Fig.8, and the curving of the roots of other extracted incisors as illustrated are more individual variations and more likely to be of environmental origin.

The apparent tendency of some lateral incisors on the mesial side of the cleft to mimic the form of a central incisor, while a resemblance to a canine can occasionally be observed on the lateral incisors on the distal surface of the cleft. (Table XV) is interesting and may explain Harvold's (1947) comment on the frequency of transpositions. The possibility that the adjacent tooth germ has contributed to or influenced the development of the lateral incisor tooth germ must be considered. However, a suggestion that environmental effects could influence two teeth derived from embryonic tissue that would have formed a single lateral incisor, but for the intervention of a cleft, to develop into teeth of different form, requires further investigation before being accepted. This/...

/This point also has implications relative to the time of tooth and cleft formation in the light of Glasstone's work.

In this study abnormalities of form of the teeth found in the rest of the dentition are minor, excepting in the patients with unilateral alveolar clefts. In these patients a number of morphological abnormalities of the upper incisors occurred on the patients' normal side. The abnormalities present in this series included 2 dichotomous central incisors, 1 deciduous and 1 permanent; 1 conical permanent lateral incisor and 2 examples of dens invaginatus (Table XVII). Therefore, there are 5 abnormalities of tooth morphology in 40 otherwise normal upper incisor segments. The high incidence of these abnormalities required explanation, especially if consideration be given to the abnormalities in the same region described in Section I. These included 2 supernumerary teeth and 2 absent permanent lateral incisors and also 1 permanent central incisor with retarded calcification.

A possible explanation of this regional grouping of abnormalities is current in the Continental dental literature; such abnormalities of tooth number and form in the lateral incisor region are considered to be caused by a developmental disturbance of insufficient severity to cause a cleft, but sufficient to disturb the formation of the teeth. The concept has not gained acceptance from the majority of dental teachers in this country, as adequate proof has been lacking. It is usually described as the 'cleft microform' hypothesis (Mengele, 1939; Fogh-Anderson, 1942). This is thought to be an inadequate/...

/inadequate descriptive term as it suggests that the defects include the presence of a minor degree of cleft. It is therefore suggested that a new term is required, and 'cleft stigmata' is suggested. Stigma is derived from the Greek word 'mark' and the American Illustrated Medical Dictionary (Dorland, 1951) includes the definition 'Any mental or physical mark or peculiarity which aids in the identification or diagnosis of a condition'.

The publication which stimulated this line of thought was that of Clement-Lucas (1888) in which was reported the absence of a lateral incisor in the mother of a child with cleft palate. This observation was also made by Berry and Legg (1912) and Richardson (1913), although without producing further evidence, but Davies (1928) observed 18 instances of absent lateral incisors in 425 relatives of children with cleft palate. The concept was enlarged to include other forms of incisor abnormalities by Preiswerk-Maggi (1908) and Herbst and Affelstaedt (1928). More recently, Mengele (1939) Krebs (1940), Fogh-Anderson (1942), and Vondra (1957) have expressed similar views, but evidence is lacking and difficult to establish. Clausen (1940) reported on one pair of apparently identical twins, one with a cleft palate, and the other showing an abnormality of the lateral incisor.

The majority of dental textbooks in the English language ignore this possible cause of dental irregularity. However, Brash (1956) refers to it and states; 'it does not by any means follow that the minor degrees of malformation represented by irregularity of the teeth stand in any relationship to the grosser conditions as part of a continuous series/...

/series with the same cause acting with various degrees of intensity'.

One method of investigation of this problem is to follow the lead of Clement Lucas's observation and note any dental abnormalities in the relatives of cleft children, in view of the known hereditary tendency of cleft palate (Fogh-Anderson 1942). The incidence of dental defects in the incisor and canine region in the relatives of cleft children was estimated by Fogh-Anderson to be 5 per cent in his series. However, many of the abnormalities recorded were possibly caused by other factors, and as an example of this is the illustration given by Fogh-Anderson of this form of defect; this is of a palatally positioned lateral incisor which is often seen as a symptom of crowding of the upper incisors.

A number of abnormalities were recorded in this study which suggested that dental cleft stigmata might be familial in cleft palate. In Fig. 18 is illustrated the dental casts of a child with a right lip and alveolar cleft, and those of his mother, who, it can be noted, had an upper permanent lateral incisor absent. In an attempt to ascertain if such abnormalities of the upper incisor teeth were a feature of relatives of children with cleft palate, 85 parents of such children were examined. The details of this group is given in the Appendix (p.124), and it can be seen that the group includes 2 instances of absence of the upper lateral incisors and 3 parents with absence of one or more premolars. Unfortunately, only 36 of the parents had good dentitions, so the sample proved a small one. The finding of absence of premolars in the parents recalled the tendency to absence of premolars/...

/premolars in the cleft study group. A familial tendency to partial anodontia could explain the absence of all such teeth including the upper lateral incisor of the parent group, as these teeth are commonly absent in this condition (Clayton, 1956). The hypothesis of dental cleft stigmata is therefore not the only possible cause of such conditions.

In the parent study group there were no abnormalities of the upper incisors similar to the abnormalities of tooth number and morphology found in the incisor region unaffected by the cleft, in the children of the patient study group with unilateral alveolar clefts. Such abnormal tooth formations are rare (Stones, 1957), and the possibility that they may be cleft stigmata cannot be entirely disregarded. However, this cannot be extended to suggest that this is a possible cause of many of the incisor irregularities seen in normal patients with malocclusion. In this study the incidence of cleft palate in the patient study group was much greater than that of the instances of possible cleft stigmata. Therefore, in the general population and even in the relatives of the children with cleft palate, abnormalities that could be described as dental cleft stigmata can be expected to be only a rare finding.

SECTION III

ABNORMALITIES OF TOOTH STRUCTURE

L I T E R A T U R E

References to abnormalities of tooth structure in cleft palate are not common, and few papers have been published on the incidence and types of defects found. Occasional general statements are to be found to the effect that the 'teeth are ill formed' (Federspiel, 1927); also Warwick James's (1916) comment that the teeth are 'honeycombed as a result of imperfect development' requires to be recorded. Olin (1960) reported that 39 out of 95 patients with cleft palate had some degree of hypoplasia of the teeth with the maxillary central incisors and the first molars being the most frequently affected teeth in the permanent dentition. He did not give details of this patient group or the definition of hypoplasia used. The details of the findings on individual teeth were not recorded and no suggestions as to the possible causes of this condition were given.

In an article discussing the dental defects in cleft palate Trusler et alii (1957), list surgical trauma as a possible cause of dental maldevelopment. This was suggested also as a cause of 'hypoplasia' of the teeth by Mink (1959). His observations in this preliminary report were on the maxillary anterior teeth as a group only and no figures for each individual tooth were given. Therefore, it is not entirely clear if an abnormality of number or structure of teeth was suggested; however, in the 71 patients examined with permanent dentitions he found a high incidence of hypoplasia of the anterior teeth in patients with all types of clefts, except those patients with a cleft of the palate only.

ANALYSIS OF FINDINGS

Incidence of Enamel Hypoplasia in Patient Study Group

The inspection of the series of children with cleft palate revealed that not only were anomalies in number and form of the teeth present, but defective surface structure in the form of enamel hypoplasia occurred in many instances. In Section II of this study, several of the specimens of extracted lateral incisors (Figs.8 - 17) show this defect. It was therefore decided to investigate the incidence and distribution of enamel hypoplasia in the children of the patient study group. Each child was examined with a dental mirror and a probe for defects of the enamel of standing teeth. Only marked defects were recorded, i.e., definite loss of surface structure or easily discernible white patches on the teeth. The method of examination and the definition of hypoplasia used were described in detail in the Introduction (p.8).

An analysis of the type of cleft to the number of patients showing enamel hypoplasia of the teeth is shown in Table XVIII

TABLE XVIII

Type of Cleft	Prealveolar Cleft	Alveolar Cleft	Postalveolar Cleft	Total Patients
Patients with Enamel Hypoplasia	2	44	4	50
Patients with good tooth Structure	2	8	16	26

This Table reveals that the patients with alveolar clefts had in the great majority of cases some degree of enamel hypoplasia of the teeth. Two of the 4 patients with a prealveolar cleft also showed this defect, but the incidence of enamel hypoplasia in patients with postalveolar cleft was only 1 in 5 patients.

The majority of the children studied were in the 4 - 6 years age-group, and therefore the largest number of observations were on the deciduous dentition. However, children were also examined at the period of the mixed dentition and a number of observations were made on the permanent teeth. The observations made on enamel hypoplasia in this group on individual teeth are due to their length, tabulated in the Appendix (Pp.140 - 150) and for convenience of study given in histogram form (Figs.19 - 22).

An overall analysis of the incidence of enamel hypoplasia in the deciduous dentition (Fig.19) revealed that a high incidence (15 - 30 per cent) of enamel hypoplasia of the upper incisors was present. In the lower incisor region the teeth were relatively free from faults, but approximately 10 per cent of the molar teeth of both arches were affected.

The number of permanent teeth examined was small, due to the age distribution of the children examined. However, the first permanent molars and the permanent incisors were present in a number of the patients and showed a small, but definite, incidence of hypoplasia in both arches of up to 10 per cent (Fig.20).

The findings in the incisor region were dissimilar in the upper and lower arch, the lower incisors were defective at approximately the level of incidence of defects of the first permanent molars, while the upper incisors especially the central incisors showed an incidence of hypoplasia as high as 50 per cent.

To further the analysis of this feature the series was divided into children with right-sided lip clefts, left-sided lip clefts, and bilateral lip clefts. When the enamel hypoplasia of anterior deciduous teeth found with a right-sided cleft is compared with that with a left-sided cleft, the result was a definite pattern of distribution of hypoplastic defects corresponding to the cleft position (Fig.21). The incidence of hypoplasia of the deciduous teeth was markedly related to the side of the cleft, with the pattern of incidence in bilateral clefts involving all the incisor teeth.

In order to differentiate between the possible effects of the various surgical procedures used for the patient study group the group was split into three sub-groups. The first were children who had required only a repair of the lip. The second group had undergone palate repair only, while the third group had required both operations. The incidence of enamel hypoplasia in the deciduous teeth in the three sub-groups is analysed and given in histogram form in Fig.22.

This reveals that only the first and third groups had a high incidence of incisor defects, although defects of the molar teeth were more frequent in the latter two groups. The degree of hypoplasia of the incisor teeth in patients requiring only a lip repair was less than that in patients requiring both lip and palate surgery, and both groups requiring palate surgery had a higher incidence of hypoplasia of the molar teeth than the group requiring only lip surgery. The number of permanent teeth examined was too small for conclusions for a similar analysis on the effect of different surgical procedures, to be valid. A tendency to follow the findings in the deciduous dentition is, however, manifest if reference is made to Tables XXXIII, XXXV, and XXXVII (Appendix, Pp.143, 145, 147).

In both dentitions the most marked feature can be summarised as an extremely high incidence of enamel hypoplasia of the incisors. A further moderate degree of enamel hypoplasia was encountered in the deciduous molars and first permanent molars.

To obtain comparative figures for the incidence of enamel hypoplasia in normal children a group of 100 school children was examined. Details of this group were given in the Introduction (P.11) and the findings are also given in the Appendix (Pp.122 - 123), with a histogram of the findings shown in Fig.23.

The findings on the cleft palate group when compared with those of the control group show a marked difference as shown in Table XIX.

Table XIX

Upper Deciduous Teeth

Individual Teeth	<u>E/</u>	<u>D/</u>	<u>C/</u>	<u>B/</u>	<u>A/</u>	<u>/A</u>	<u>/B</u>	<u>/C</u>	<u>/D</u>	<u>/E</u>
Per cent Hypoplastic in Cleft Group	8.5	10.2	5.9	12.7	26.8	21.8	12.1	8.5	8.6	6.9
Per cent Hypoplastic in Control Group	4.1	4.1	2.1	4.	5.7	7.	3.9	1.	1.3	3.7
<u>Lower Deciduous Teeth</u>										
Individual Teeth	<u>E/</u>	<u>D/</u>	<u>C/</u>	<u>B/</u>	<u>A/</u>	<u>/A</u>	<u>/B</u>	<u>/C</u>	<u>/D</u>	<u>/E</u>
Per cent Hypoplastic in Cleft Group	7.4	11.5	2.9	3.6	4.1	4.	3.6	1.4	9.4	5.9
Per cent Hypoplastic in Control Group	2.8	1.3	1.1	1.7	4.	4.	3.3	1.1	1.4	1.3

If the observations made are grouped into those on molars, canines, and incisors of each dentition, a statistical analysis is possible and is given in the Appendix (Pp.127 - 130).

A significantly higher incidence of enamel hypoplasia in the cleft palate patients as compared with control series is shown in all groups of teeth excepting the deciduous incisors and canines.

Histological Examination of 4 Extracted Central Incisors

The collection of extracted teeth from children with cleft palate included 4 central incisors with defective structure. There were 2 deciduous central incisors extracted from a patient for orthodontic reasons, and 2 permanent incisors extracted from different patients for aesthetic reasons.

The deciduous central incisors were extracted from a boy aged 7 years with a right lip and alveolar cleft. The lip repair had been carried out at 3 months and the palate repaired at 23 months. An Angle Class III malocclusion was present and the deciduous central incisors were extracted as they were deflecting the eruption of the permanent incisors palatally.

SPECIMEN 11 (Fig.24) - Right deciduous central incisor from margin of an alveolar cleft. The photographs and ground-sections shows extensive caries which had destroyed much of the enamel and penetrated into the dentine. An area of abnormal curvature of the dentinal tubules in cervical part of the labial surface of the crown is matched by a large deposit of secondary dentine on the pulpal surface.

SPECIMEN 12 (Fig.25) - Left deciduous central from the same patient as Specimen 11. The photographs shows that the mesial corner of the crown had been lost and the labial cervical margin was carious. The ground-section shows the enamel well formed except at the labial cervical margin. An area of caries is here seen penetrating the dentine, with a compensatory formation of secondary dentine on the pulpal surface.

The 2 extracted permanent incisors were from different patients. The first was from a girl of 10½ years with a right lip alveolar and palate cleft. Lip repair was at 5 months and palate repair at 2 years 5 months. 1/ was extracted because dental caries on the root surface had extended too far for satisfactory conservation.

SPECIMEN 13 (Fig.26) - The clinical photographs show 1/ in the margin of a cleft and in linguo-occlusion. There is a distal carious cavity and an area of hypoplasia on the labial surface. The ground-section shows an essentially normal picture of tooth tissue, except at the tip of the crown. Here there is an hypoplastic defect on the upper labial surface of the enamel, partially filled with amorphous enamel substance, and also a small enamel defect at the same level on the palatal surface. The tip of the incisor has been formed normally, although a certain loss of substance from the enamel cap may have occurred.

The second permanent incisor was from a boy aged 10 years with a right lip alveolar palate cleft; the lip was repaired at 6 months and the palate at 3 years 8 months.

SPECIMEN 14 (Fig.27) - The clinical photographs show 1/to be rotated and distopalatally placed. Severe generalized hypoplasia of the enamel is visible. The ground-section reveals a tooth with severe hypoplasia of the enamel. This is evident at the tip where a small area on the labial surface is filled with amorphous enamel material, and is also seen both on the labial and the palatal surface of the cervical third of the crown, where severe defects in enamel formation are apparent. This is matched on the palatal surface by a marked incremental line in the dentine and a plug of secondary dentine in the pulp.

DISCUSSION

The observations on the patient study group confirm the findings of Mink (1959) and Olin (1960) that enamel hypoplasia is a common feature in children with cleft palate. It is especially marked in the upper incisor region in both dentitions with the teeth adjacent to a cleft. As with Mink's observations the patients with a cleft limited to the palate did not show this high incidence of incisor defects.

The deciduous molars showed an incidence of enamel hypoplasia significantly higher than in a normal series of children and the first permanent molars are affected at approximately the same level. The lower deciduous incisors are relatively free from such defects and show a similar incidence to the control series.

The types of defective structure found were shown in the series of 4 central incisors examined, (Specimens 11 - 14, Figs. 24 - 27). These showed localised defects in the enamel, especially in the 2 permanent incisors. In 2 of these teeth abnormalities of dentine structure were observed adjacent to the area of an enamel defect, while elsewhere the tooth showed no marked defects. Also in the series of 10 extracted lateral incisors examined in Section III (Specimens 1 - 10, Figs. 8 - 17) and described in detail in the Appendix (Pp. 132-139) enamel hypoplasia was visible clinically in 6 of the 10 teeth and also in 3 of the 6 histological ground-sections illustrated.

The possible causes of a high incidence of defective structure of the teeth in children with cleft palate can be conveniently considered under the headings (1) Inherited and congenital; (2) Traumatic; (3) Nutritional. The involvement of teeth other than those in the margin of a cleft suggests that causes other than the local effects on tooth formation of the formation of the cleft or of an associated deficiency of blood supply are operative.

A wide variation between the incidence of enamel hypoplasia in individual teeth suggests that it would be incorrect to suggest a generalized congenital defect of tooth formation. The relatively normal formation of the deciduous lower incisors suggests that any generalized disturbance of tooth formation must be postnatal in timing as the crowns of these teeth are almost entirely formed at birth.

The analysis of the time of interruption of formation of a tooth is aided by a knowledge of the time of calcification of the tooth involved. Stones (1957) states that 'from the knowledge of the date of mineralization of the various teeth it is possible to tell the exact time at which the local factor or systemic disease has been in progress and affecting them.' Schour (1953) gives a table of calcification times of the teeth. It is stated that the permanent incisors and canines begin to calcify in the first 6 months after birth, with the lateral incisor calcifying at 10 months. There is a natural variation in the time of tooth development and they give ± 2 months as the variation in the first year of life. The different date of calcification of the permanent lateral incisor is a valuable diagnostic point. In the deciduous dentition the crown/...

/crown of the first incisor is nearing completion at birth while the second incisor and canine crowns are completed in that sequence in the first 9 months after birth. The crowns of the deciduous molars are also completed in the first year of life.

If the above information on times of tooth formation is related to the defects found in the group of 4 extracted centrals an attempt at dating the time of developmental disturbance can be made. In Specimen 11 (Fig.25), an abnormality of the dentine was present in the cervical part of the crown which can be dated to the period of the first 3 months after birth, while a carious cavity was visible in the same region in Specimen 10 (Fig.24). In the 2 permanent incisors the appearances were more striking. In Specimen 12 (Fig.26), the enamel defect is at the tip of the cusp and can be dated as at 6 months \pm 2 months, while in Specimen 13 (Fig.27) a similar defect is present at the tip of the cusp and also a severe disturbance of structure was present in the centre of the crown, and this can be dated at 2 - 3 years. In these teeth, therefore, the defects of structure can be dated approximately to periods when the patient was undergoing surgical repair of either the lip or palate.

Some information on the effects of surgical trauma on the development of teeth is available and the effect of other forms of trauma is well known, and Turner (1909) gave his name to the malformed teeth that may result from infection of the preceding deciduous tooth. Rushton (1958) presents clinical records and histological material of a permanent lower incisor damaged by a jaw/...

/jaw injury at 2 years of age. The dentine shows a line of interruption associated with the injury to the growing tooth and the enamel is roughly formed. Also, there is evidence of an attempt at partial reduplication. Confirmation of the effect of direct surgical trauma on the development of a tooth germ was shown by Bauer (1928). Using experimental operations on the jaws of dogs of 11 - 12 weeks of age, he found that the enamel epithelium, if damaged, does not tend to regenerate. Further studies were carried out by Santone (1937), who penetrated developing tooth germs of newborn guinea pigs and cats with a broad needle and observed that the ameloblasts always degenerated.

A number of statements as to the effect of earlier techniques of surgical repair on the teeth in cleft palate are available. Federspiel (1927) in describing the Brophy method of wiring the upper jaw states: 'The trauma produced will usually destroy some of the tooth buds'. Also, Thoma and Goldman (1960) write: 'In Brophy's method of cleft palate operation, teeth were frequently injured when wires were passed through the alveolar bone. Operative injury is more common in the region of the alveolar cleft and is often associated with maldevelopment of the canine and second incisor'. Methods such as Brophy's wiring technique have been abandoned by most surgeons. Emphasis is now placed on a conservative approach to surgery (Kilner, 1958), but in contrast to this MacGregor (1959), while discussing various types of lip repair, states that there are basic steps common to all types of repair including the mobilization of the cheek/...

/cheek from the maxilla almost up to the infraorbital margin.

In Edinburgh there has been a trend towards a much less extensive operative procedure, but whatever the type of operation performed it is certain to be followed by some degree of local tissue damage, and the suggestion of Olin and Mink that it may result in tooth damage must be considered. The present tendency in Edinburgh of the surgeons undertaking cleft palate surgery is to consider lip surgery at 3 months and palate surgery at 18 months. The variation in the times and type of surgical repair in this condition discussed in the Introduction (Pp.14 - 15), together with the variation in the times of mineralization of the teeth, would mean that dental defects caused by operative procedures could not be expected to be of an absolutely constant type.

The tendency for localization of the hypoplastic defects of the teeth in the cleft margin to defects of the tooth structure formed postnatally, can be better related to local trauma than to a congenital abnormality or nutritional defects. Further, the distribution of defects of tooth structure in individual patients indicate that a local factor, rather than systemic factor, was causative in the majority of cases. The contrast was marked in the 2 patients (Nos.44 and 52) with a history of systemic illness or disturbance; here a generalized distribution of enamel defects was visible. Unfortunately, no specimens of deciduous molar teeth became available for histological examination, as it was not considered justifiable to extract such teeth except when caries/...

/caries had rendered them unsavable and by that time any structural defects had often been obliterated.

That the hypoplastic defects are not entirely limited to the incisor teeth is shown by a study of the histogram (Fig.19). The deciduous molars and the first permanent molars all show an incidence of enamel hypoplasia greater than that shown in the control group (Fig.23). All these teeth are forming in the immediate postnatal period and the possibility that they may have been affected by the systemic effects of the operative procedures the child has undergone must be considered. Reference to Fig.22 shows that the patients with palate clefts, both without and with an associated alveolar cleft, show a higher incidence of defects of the deciduous molars than patients with only a lip cleft. This could not be attributed to the direct or indirect effect of the surgical repair of the palate as this occurs later than the formation of the crowns of the deciduous molars. It must be born in mind also that an infant with a palate cleft is prone to feeding problems after birth (Olin, 1960) with a possibility of being sickly and undernourished and this may also cause some disturbances in tooth formation.

When the finding of an extremely high incidence of enamel hypoplasia of the incisor teeth of both dentitions in children with clefts of the lip and the alveolus is considered, the clinical and histological analysis strongly suggests that the surgical repair of both lip and palate can contribute to this defect. The lip repair would appear likely to cause enamel hypoplasia of the necks of crowns of the deciduous incisors and the tips of the crowns of the permanent incisors related to the area of operation. The palate repair could be considered as causative of some of the defects in the body of the crown of the permanent incisors. The systemic effects of both operations and the feeding problems associated with the condition must also be recognized as potentially harmful to dental development. A conservative approach to surgical repairs of clefts should be favoured as less likely to result in tooth maldevelopment, and consideration should be given to any techniques which lessen the degree of surgical trauma, or reduce the feeding problems of babies with cleft palate.

SUMMARY AND CONCLUSIONS

This study is concerned with the abnormalities of the teeth of children with cleft palate. A series of 76 child patients were dentally examined, with the aid of radiographs and dental study casts. The deciduous and permanent dentition of each child was studied; this was possible as the children were either aged from 4 to 6 years or previous records of the deciduous dentition were available. The study was confined to abnormalities of number, external form, and the structure of the teeth, both in the vicinity of a cleft and elsewhere in the dentition.

(References to the abnormalities of the teeth in patients with cleft palate are widely found in both medical and dental literature. These are reviewed and discussed in relationship to the findings of this study. Supplementary clinical and histological material was collected in the period of the study and is presented to further illustrate points under discussion. The findings on abnormalities of tooth number and enamel hypoplasia in the patient control group are compared with findings in comparable control groups of normal children also examined. It is hoped that a study in this form will be useful to give a more comprehensive picture of the cleft palate dentition than was previously available. The following observations were made and conclusions reached in this study within the sample of children examined.

The deciduous dentition was formed to be normal in number in the majority of patients, but supernumerary lateral incisors were not uncommon (18 cases in 70 clefts) associated with lip or lip and alveolar clefts. Occasional instances of absence of the lateral incisors in the margin of an alveolar cleft occurred (8 instances in 70 clefts), but shedding of the deciduous lateral incisor soon after birth could account for this abnormality to some extent. Apart from these abnormalities in the cleft site, no other abnormality of tooth numbers was observed.

The form of the deciduous teeth in the patient study group was also usually normal, but associated with alveolar clefts a proportion of lateral incisors (13 of 79 teeth) had a tuberculate form. These tuberculated teeth revealed a considerable variation of morphology, but no single abnormal form of lateral incisor was found which could be considered as specific to cleft palate patients. Minor abnormalities of tooth form only were observed in the deciduous molars.

A considerable degree of defective structure of the deciduous teeth in the form of enamel hypoplasia was observed in the patient series. The upper incisors and canines together with the deciduous molars showed a significantly higher incidence of enamel hypoplasia in the patient study group than the teeth of the control group of normal children. The lower incisors and canines did not show this defect to the same degree, and in the patients with postalveolar clefts only the upper incisors were also relatively free from enamel hypoplasia.

In contrast with the deciduous dentition the permanent dentition of the patient study group frequently showed abnormalities of tooth number. In 20 of the 76 patients absence of one or more premolar teeth was observed, a significantly higher incidence than in a comparable control group of normal children. Also, upper lateral incisors were absent in the region of lip or lip and alveolar clefts in 24 of 70 clefts. Two instances of absent upper lateral incisors were observed in the 20 patients with postalveolar clefts only, and 2 further instances occurred on the side opposite to an alveolar cleft, and finally 1 case of an absent lower incisor occurred. The distribution of congenitally absent teeth suggested that partial anodontia was an associated feature of cleft palate, and this possibility was strengthened by the finding that congenital absence of upper lateral incisors and premolars also occurred in parents of children with cleft palate.

No abnormalities of permanent molar or premolar form were observed in this patient study group, although 3 examples of retarded calcification of permanent molars occurred. The lateral incisor in the margin of an alveolar cleft was frequently conical in form (28 of 59 teeth); 2 examples of dens invaginatus were observed in these teeth and a further 2 instances occurred in lateral incisors apart from the cleft and the anomaly was also seen in minor degree in 2 of a collection of 10 extracted lateral incisors also described in this study.

In the permanent dentition the number of teeth examined for enamel hypoplasia in the patient series was small and confined mainly to the incisor teeth and first molars. The first permanent molars showed approximately a 10 per cent incidence of this defect, but the upper incisors were extremely defective with up to 50 per cent classified as hypoplastic.

When the abnormalities of the deciduous and permanent teeth of the same patient were compared it was noted that with an alveolar cleft it was usual for the permanent lateral incisor to be more commonly absent than the deciduous lateral incisor. However, when a supernumerary deciduous lateral incisor was present it was often followed by a supernumerary permanent lateral incisor (13 in 18 cases). In both dentitions the degree of severity of the cleft influenced the resultant dental deformity; lip clefts were associated with supernumerary lateral incisors in one-half of the cases seen, while with clefts involving the alveolar ridge absence of the permanent lateral incisor frequently occurred. The association of a postalveolar cleft with an alveolar cleft did not affect the types of dental deformities found. Patients with postalveolar clefts only showed no numerical abnormalities of the deciduous incisors, but in the permanent dentition two lateral incisors were absent.

The most frequent position of an alveolar cleft in the patient study series was to separate the central incisor and lateral incisor. This occurred in 38 of 70 clefts in the deciduous dentition and 27 of 70 clefts in the permanent dentition. The second most common position was in the deciduous dentition for the cleft to separate the lateral incisor from a supernumerary lateral incisor, while in the permanent dentition the cleft separated the central incisor from the canine with absence of the lateral incisor. In only 2 instances in both dentitions in this study did the cleft separate the lateral incisor from the canine. This indicated that a hypotheses that relates the position of an alveolar cleft to the sutural system of the premaxilla cannot be supported. The finding that the lateral incisors on the mesial margin of a cleft occasionally resembled a central incisor while a 'canniform' type of lateral incisor was also occasionally found on a distal margin of a cleft suggested that these teeth were formed from individual tooth germs, and that the lateral incisor tooth germ was not split by the cleft formation.

Abnormalities of tooth number and tooth form were also present on the normal side of the upper segment in patients with unilateral alveolar clefts. The possibility that these may have resulted from an aborted cleft is discussed, and a new term dental 'cleft stigmata' is proposed as an improvement on present term of 'microform cleft'.

The presence of enamel hypoplasia of the permanent incisors and first molars and its occurrence on all the deciduous teeth excepting the lower incisors and canines suggested that the cause was a postnatal disturbance.

The disturbances of nutrition which can occur in children with a cleft palate, and the systematic effects of the reparative surgery, may explain the incidence of defective structure in the molar teeth of both dentitions. However, the histological examination of 2 deciduous upper central incisors and 2 such permanent incisors with clinical hypoplasia, revealed that defects in enamel structure were present that could be dated to periods of tooth development coincident with the operative repair of the lip and the palate.

The possibility of a direct relationship between the trauma of operative repair of the lip and defective structure of the deciduous incisors, and a similar relationship between both lip and palate repair and defective formation of the permanent incisors is discussed. The evidence for such a relationship was strengthened by the extremely high incidence found in both dentitions of enamel hypoplasia of the upper incisors, and its distribution mainly on the incisor teeth in the region of the cleft.

A C K N O W L E D G E M E N T S

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The following members of the staff of the Edinburgh Dental School and Hospital have given me valuable guidance on many of the aspects of this study: Dr. C. H. Kemball, Dr. D. M. Watt, Mr. A. R. Bradshaw, Mr. A. E. Duvall, Dr. G. B. Hopkin, Dr. J. N. Mansbridge, and Mr. G. James.

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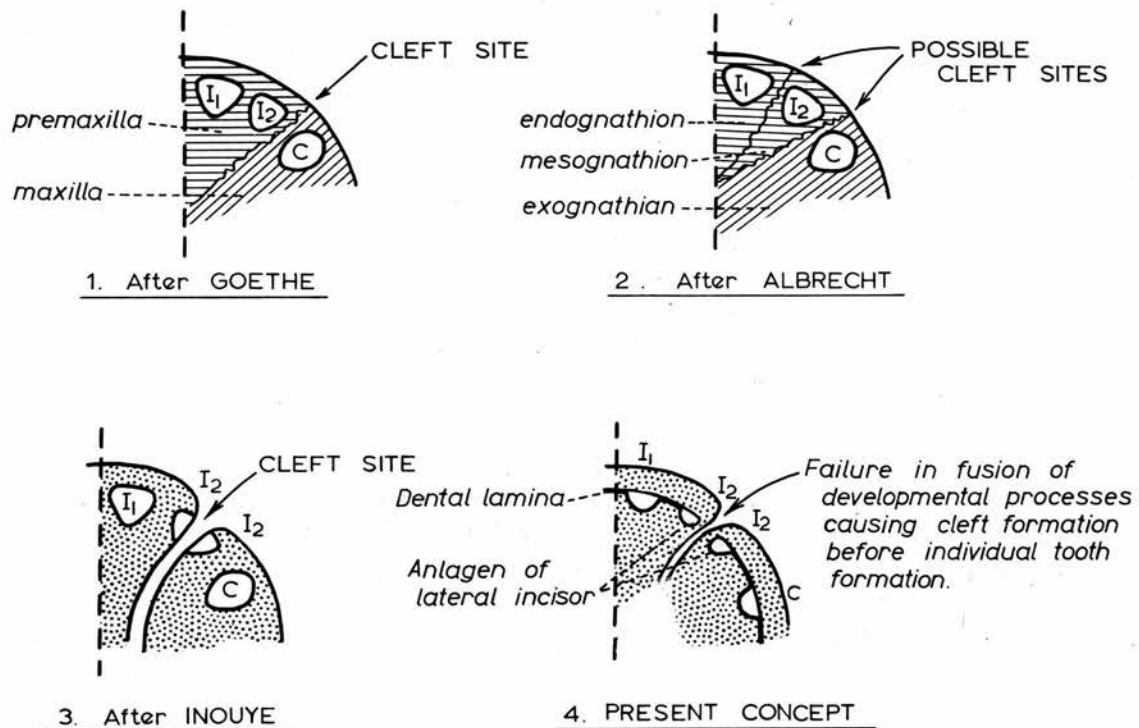


Fig. 1 -

Illustration of the theories available to explain the relationship of a cleft to the adjacent teeth.

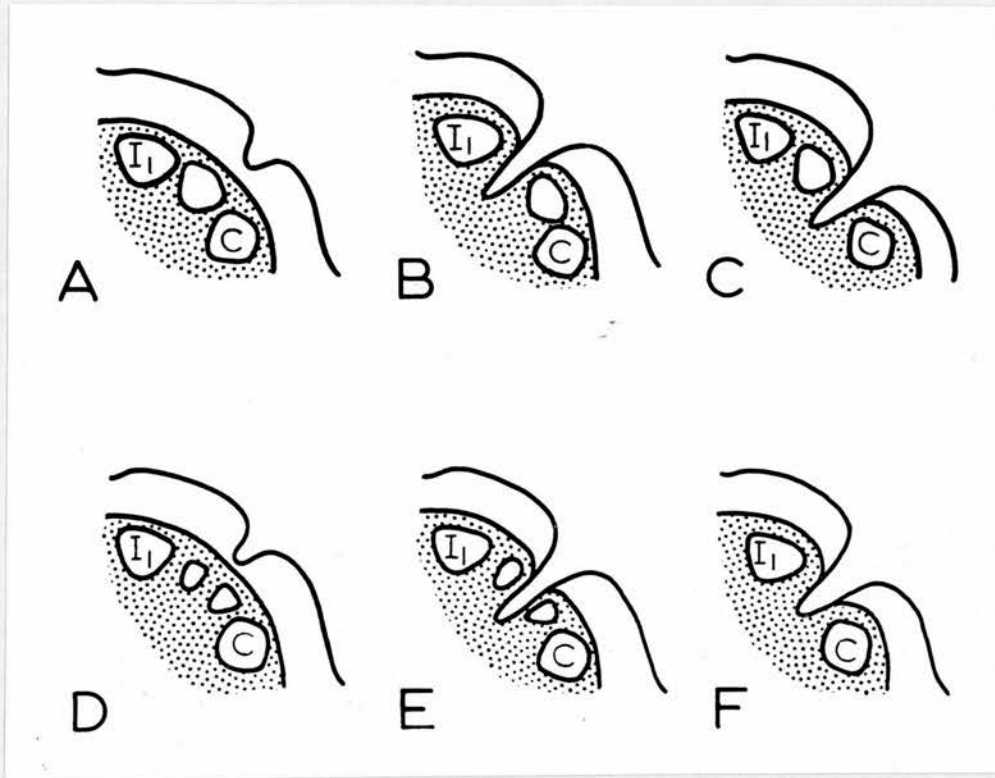


Fig.2 - Variants of number and relationship of the incisor teeth to clefts of the primary palate.

I₁

J - Central incisor; C - Canine

(Teeth in the cleft margin other than central incisors)
(and canines are considered as lateral incisors)

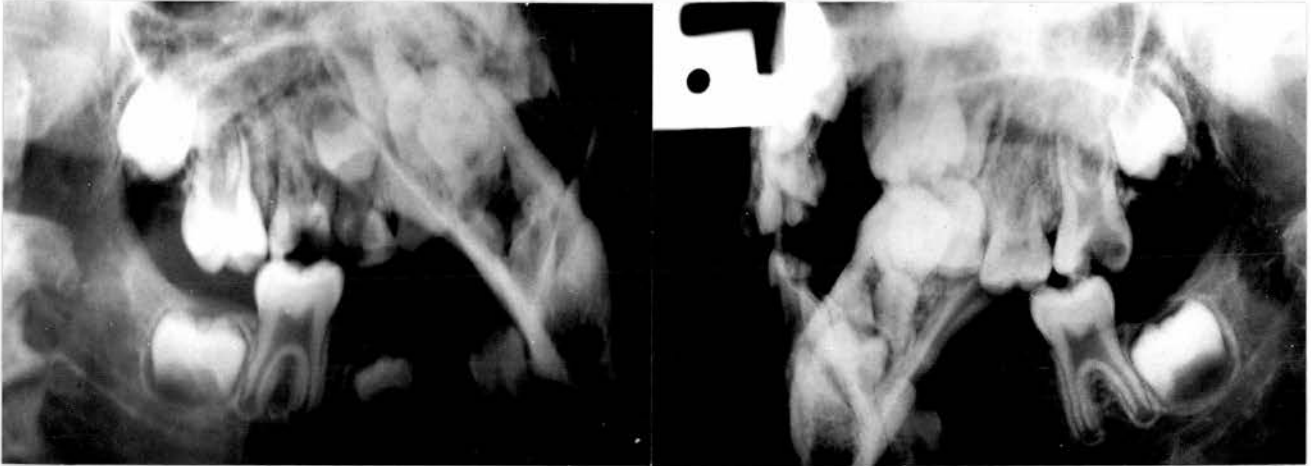


Fig.3 -
Congenital absence of premolars in patient with cleft
palate (Patient Record No. 48)

$\frac{5}{4} / \frac{5}{45}$ absent; $\frac{\text{EDC}}{\text{CDE}}$ have been extracted.

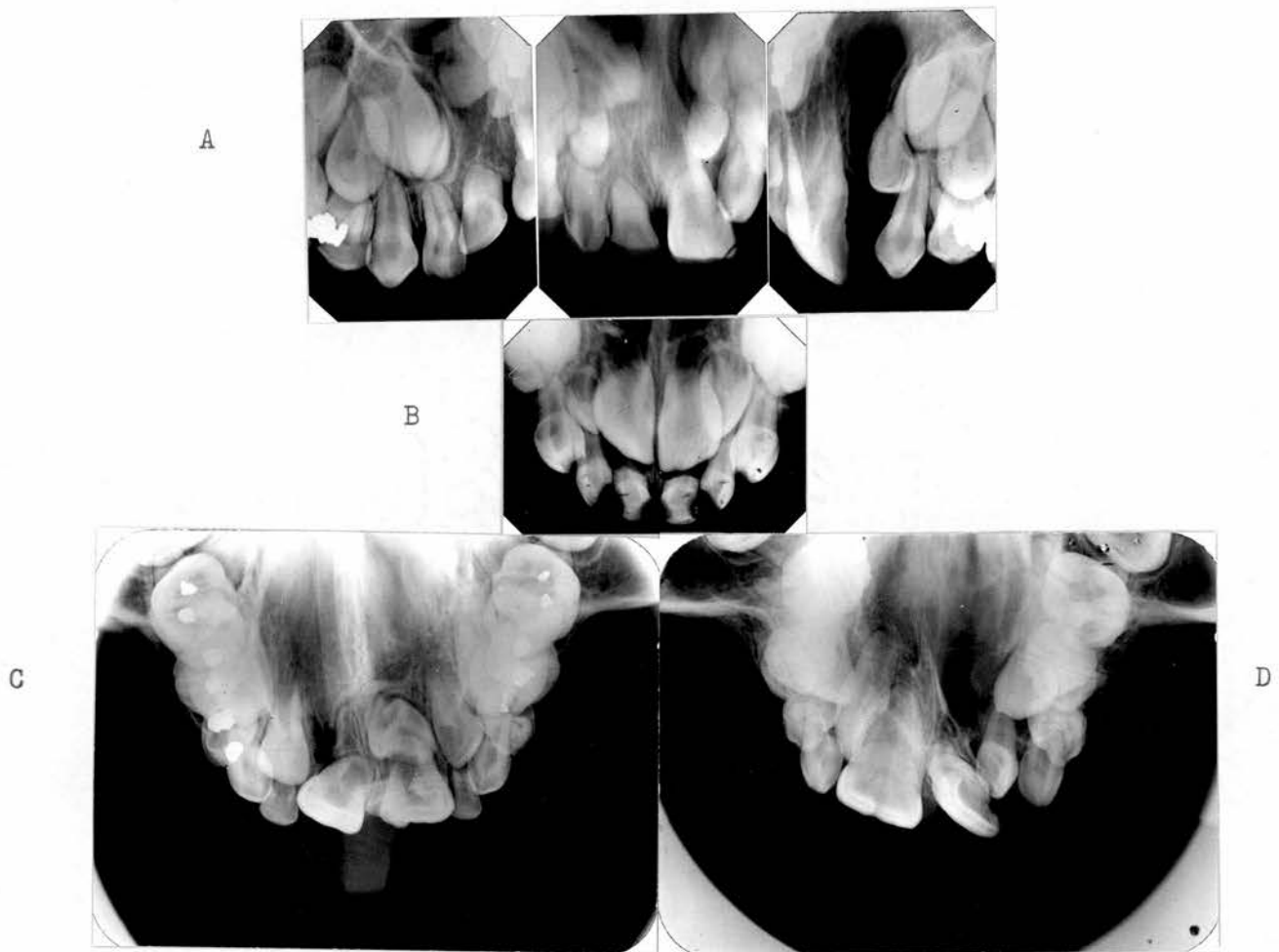


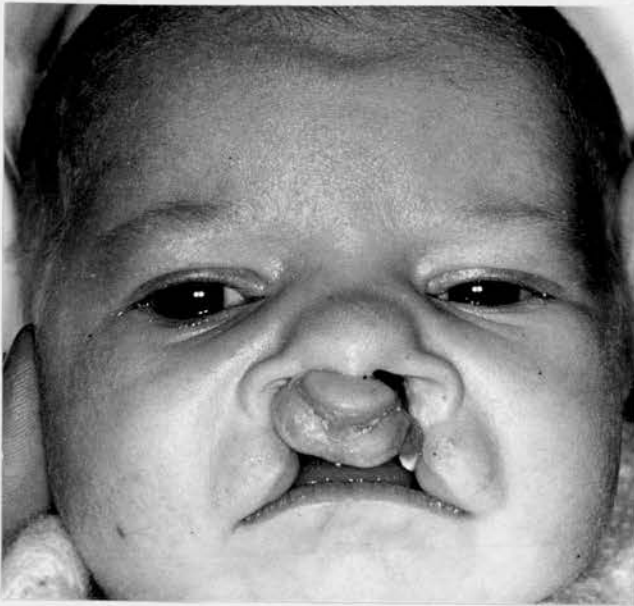
Fig. 4 -
Abnormalities of the incisor teeth away from the vicinity
of a cleft.

A, Retarded formation of 1/
(Patient Record No. 16, Bilateral lip, left alveolar
palate cleft).

B, Conical 2/
(Patient Record No. 18, Postalveolar cleft).

C, Supernumerary incisor palatal to central incisors
(Patient Record No. 39, Right lip and alveolar cleft).

D, Dichotomous formation of 1/
(Patient Record No. 15, left lip, alveolar palate cleft).



A



B

Fig. 5 -

A, Baby aged 2 weeks, with bilateral lip, alveolar palate cleft. A tooth is exfoliating from mesial margin of the left alveolar cleft.

B, A histological preparation of above tooth. The degree of calcification is consistent with this tooth being a lateral incisor.

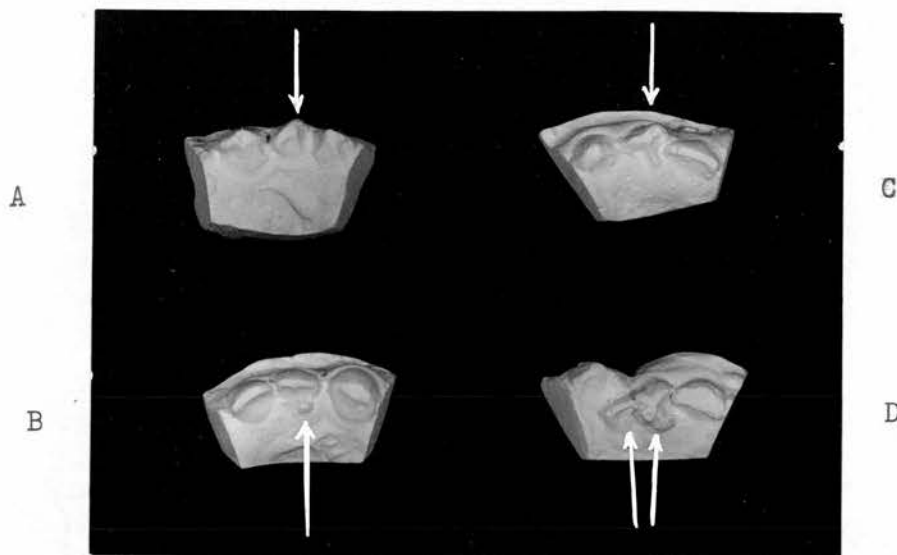


Fig. 6 - Deciduous lateral incisors of tuberculate form.

- A, Deciduous upper left lateral incisor classified as a Colyer Group IV type showing marked palatal ridge.
(Patient Record No. 45, postalveolar cleft).
- B, Deciduous upper left lateral incisor with palatal ridge and cingulum development; Colyer Group IV
(Patient Record No. 21, left prealveolar cleft).
- C, Deciduous upper right lateral incisor with typical Colyer Group IV formation, with strong ridge and cingulum.
(Patient Record No. 16, bilateral lip, left alveolar palate cleft).
- D, Deciduous lateral incisor (bD /) showing more complex tuberculate formed classified as Colyer Group VI form
(Patient Record No. 66, right lip, alveolar, palate cleft).

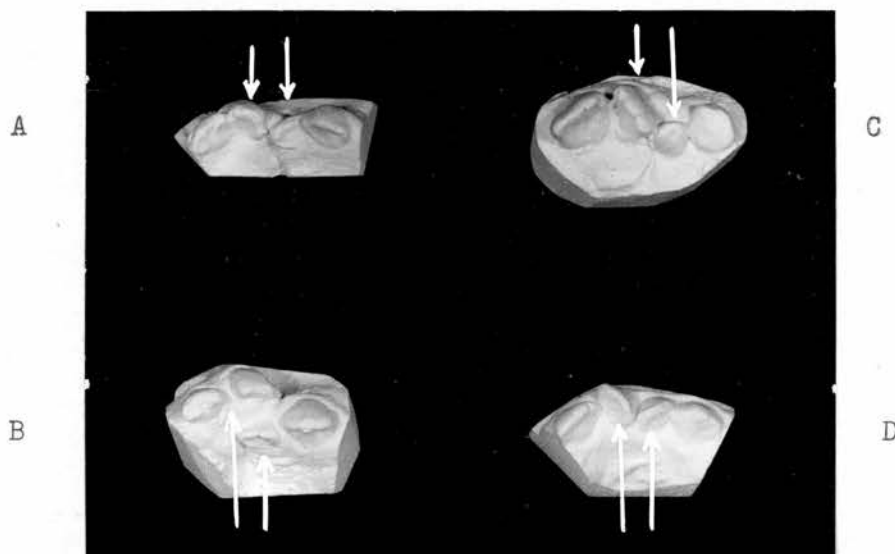


Fig. 7 - Abnormalities of morphology of lateral incisors related to clefts of the primary palate.

- A, /bM with tuberculate form;
/bD small 'canniform' tooth
(Patient Record No. 11, Bilateral lip, alveolar palate cleft).
- B, /bM incisiform tooth resembling central incisor
/bD of Colyer Group III form
(Patient Record No. 43. Left lip, alveolar, palate cleft).
- C, /2M incisiform tooth resembling central incisor
/2D conical form
(Patient Record No. 22, Bilateral lip cleft, right alveolar palate cleft).
- D, /bM incisiform tooth
/bD 'canniform' tooth form
(Patient No. 41, Left prealveolar cleft).

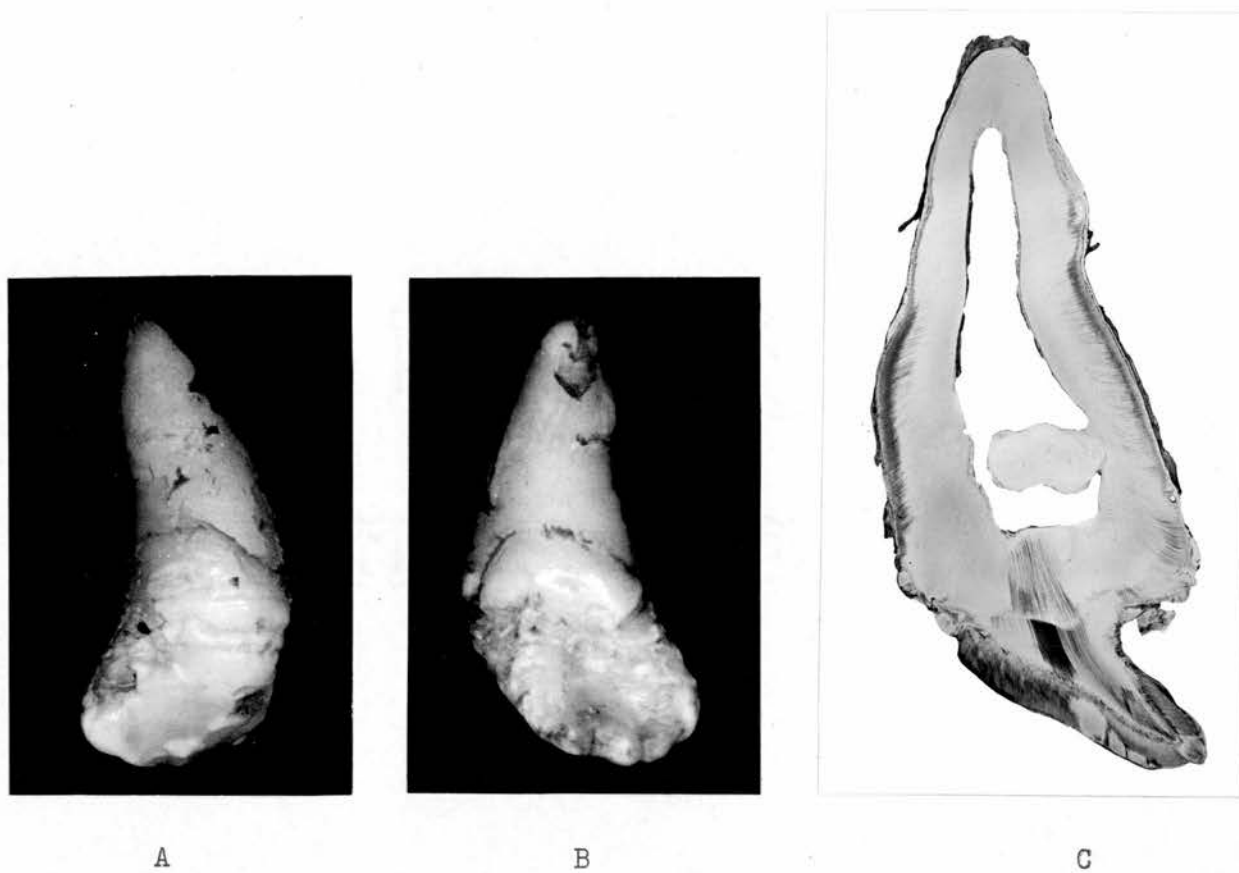


Fig.8 - Permanent upper left lateral incisor from mesial cleft margin (Specimen 1)

- A, Labial surface (X3);
- B, Palatal surface (X3);
- C, Histological ground-section (X5).

Detailed description in Appendix (p.132)

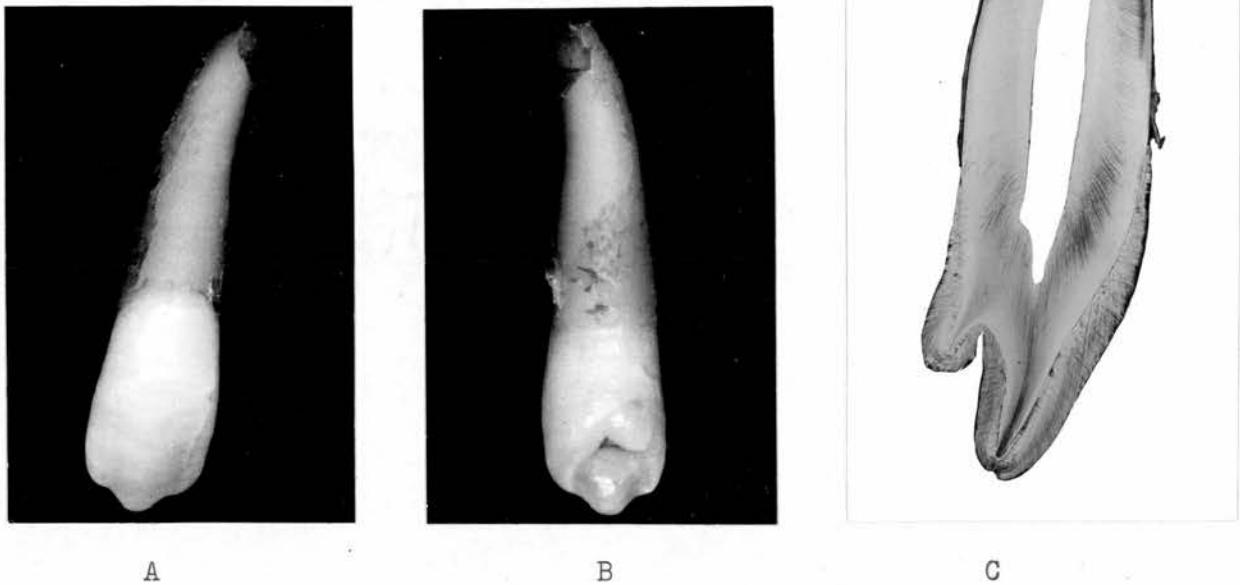


Fig.9 - Permanent upper left lateral incisor from distal cleft margin (Specimen 2).

- A, Labial surface (X3);
- B, Palatal surface (X3);
- C, Histological ground-section (X5).

Detailed description in Appendix (p.133)

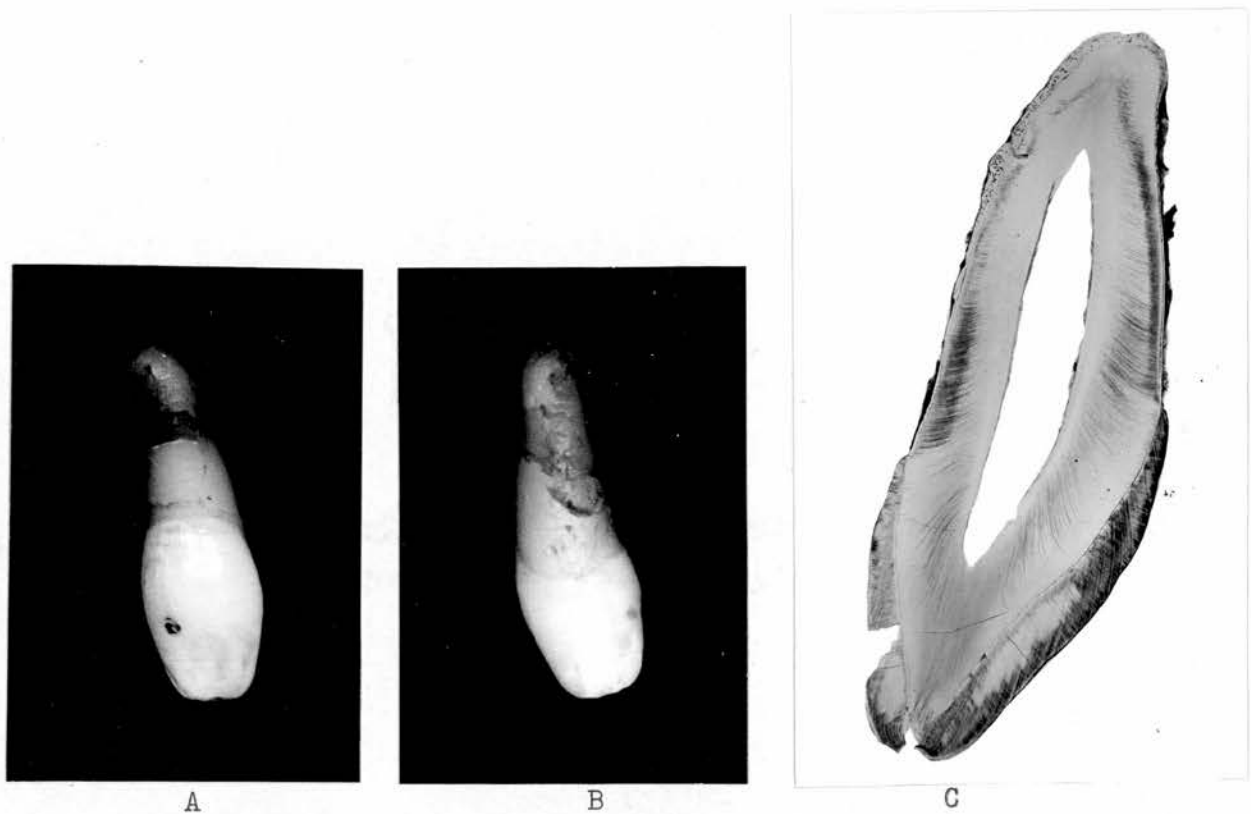


Fig.10 - Permanent upper right lateral incisor from mesial margin of cleft (Specimen 3).

- A, Labial surface (X3);
- B, Palatal surface (X3);
- C, Histological ground-section (X5).

Detailed description in Appendix (p.134).



Fig. 11 - Permanent upper right lateral incisor from distal cleft margin (Specimen 4)

- A, Labial surface (X3);
- B, Palatal surface (X3);
- C, Histological ground-section (X5)

Detailed description in Appendix (p.135)



A



B



C

Fig. 12 - Permanent upper left lateral incisor from distal cleft margin (Specimen 5)

- A, Labial surface (X3);
- B, Palatal surface (X3);
- C, Histological ground-section (X5)

Detailed description in Appendix (p.136)



Fig.13 - Deciduous upper left lateral incisor from distal cleft margin (Specimen 6)

- A, Labial surface (X3);
- B, Palatal surface (X3);
- C, Histological ground-section (X5)

Detailed description in Appendix (p.137)



A



B

Fig. 14 - Deciduous left upper lateral incisor from distal cleft margin (Specimen 7)

A, Labial surface (X3);

B, Palatal surface (X3);

Detailed description in Appendix (p.138)



A



B

Fig. 15 - Permanent upper left lateral incisor from distal cleft margin (Specimen 8)

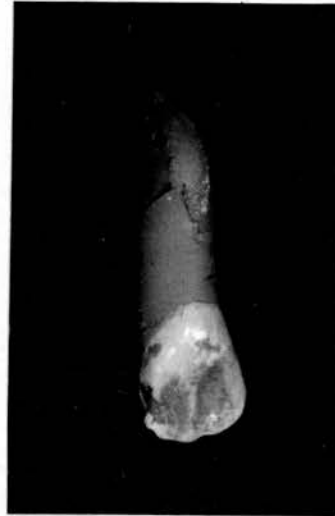
A, Labial surface (X3);

B, Palatal surface (X3);

Detailed description in Appendix (p.138)



A

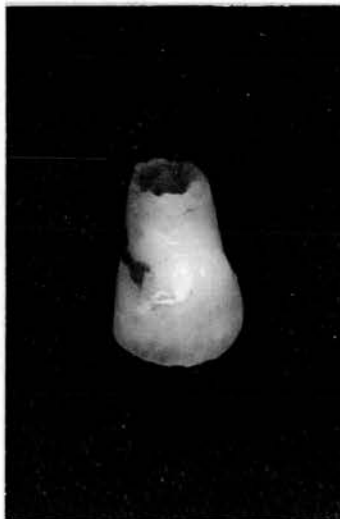


B

Fig. 16 - Deciduous upper left lateral incisor from distal cleft margin
(Specimen 9)

- A, Labial surface (X3);
B, Palatal surface (X3);

Detailed description in Appendix (p.139)



A



B

Fig.17 - Deciduous upper left lateral incisor from distal cleft
margin (Specimen 10)

- A, Labial surface (X3);
B, Palatal surface (X3);

Detailed description in Appendix (p.139)



A



B

Fig. 18 -

- A, Maxillary dental cast of boy with left lip, alveolar palate cleft.
- B, Maxillary dental cast from mother of above boy.
Absence of 2/ and irregularity of 1/

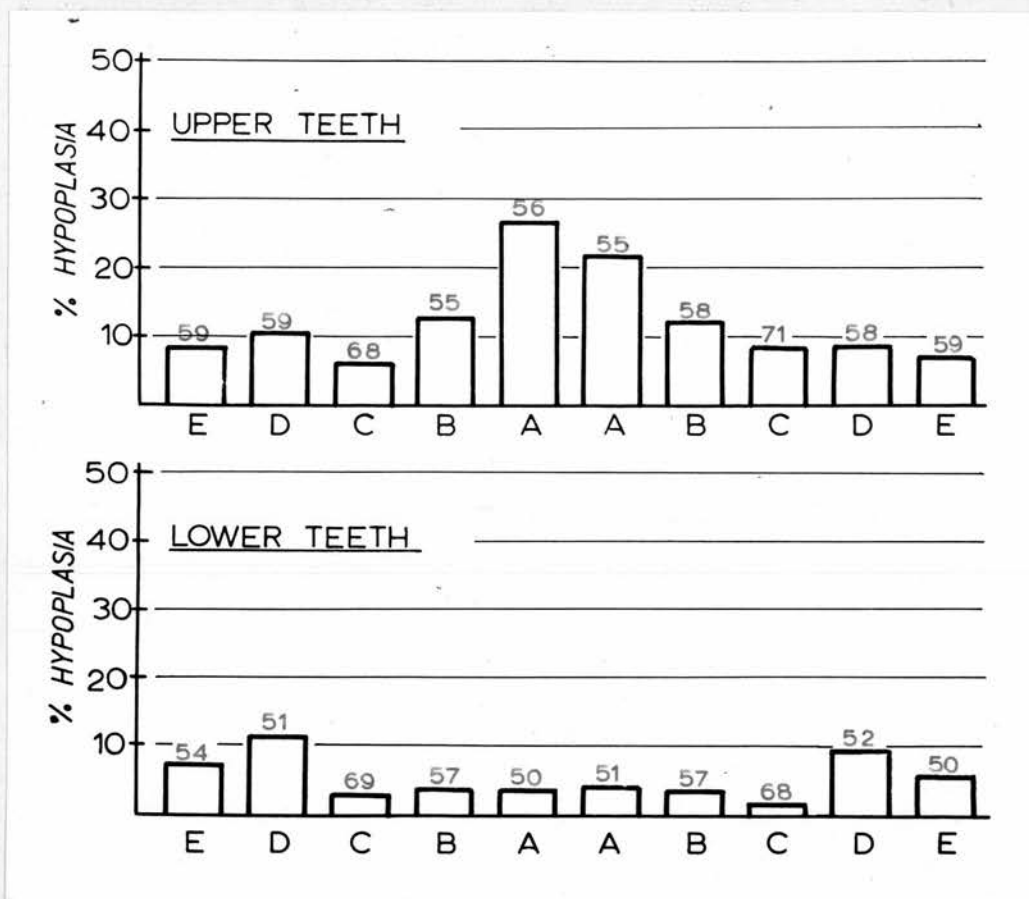


Fig. 19 - Histogram of enamel hypoplasia of deciduous teeth in patient study group (Table XXX, Appendix, P.140).

The number of individual teeth examined is given above each block.

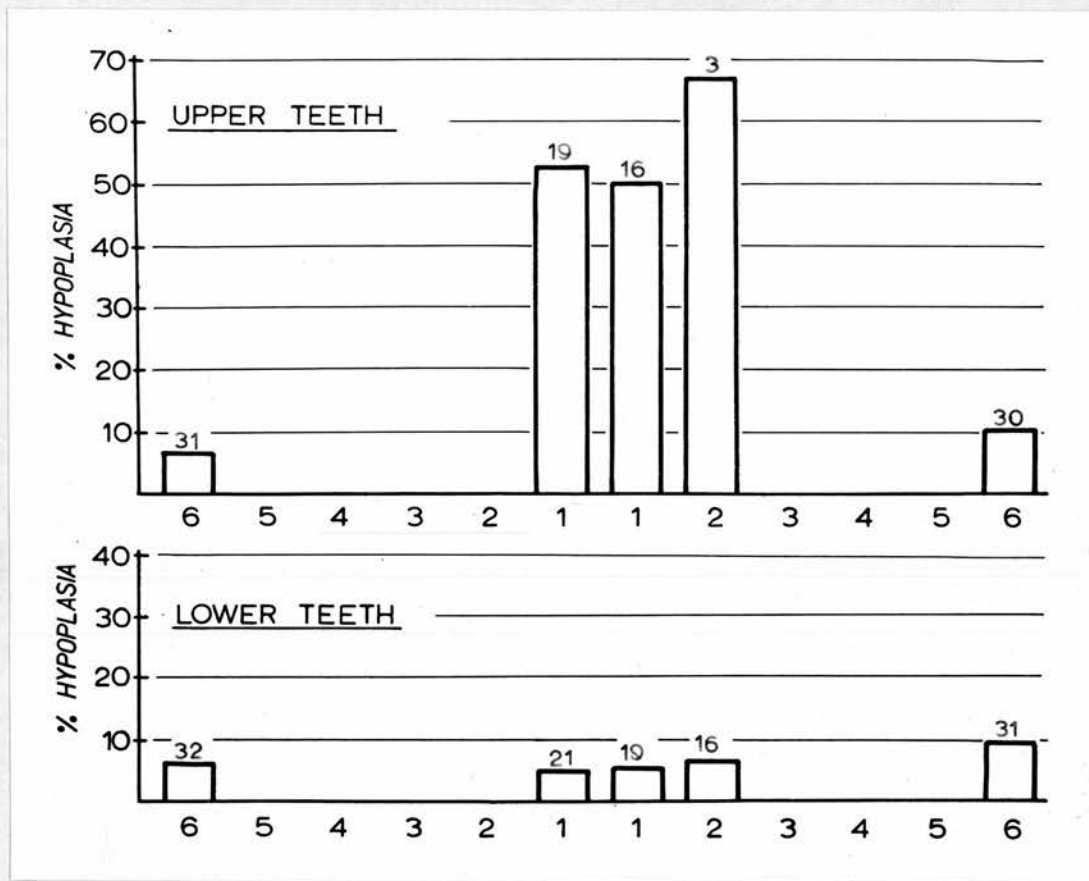


Fig. 20 - Histogram of enamel hypoplasia of permanent teeth in patient study group (Table XXXI; Appendix, P.141).

The number of individual teeth examined is given above each block.

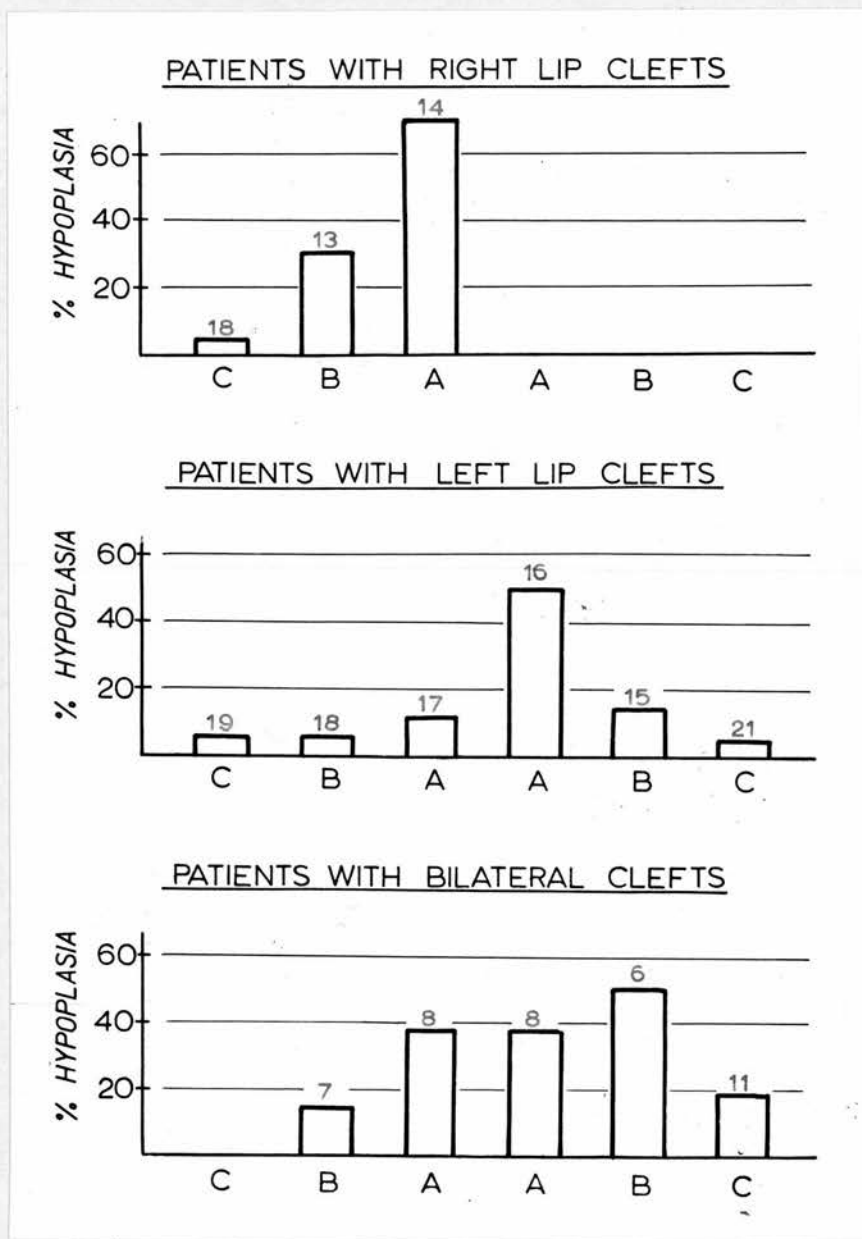
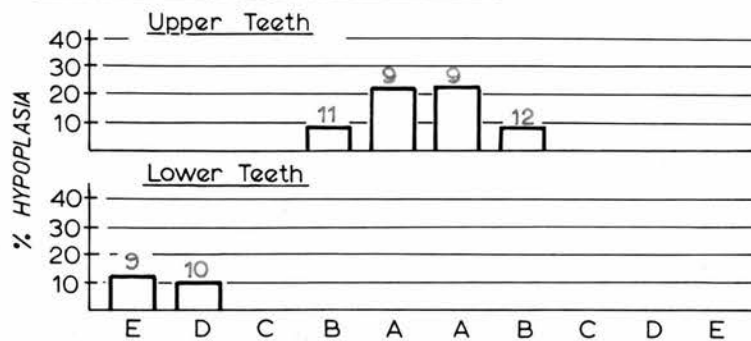


Fig. 21 - Histogram of enamel hypoplasia of deciduous upper incisors in patient study group related to side of cleft.

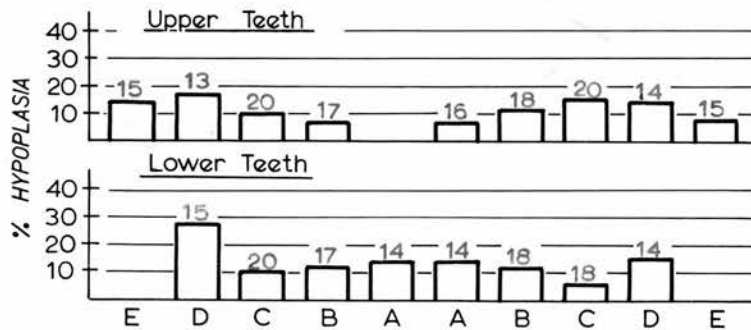
(Tables XXXVIII - XL; Appendix Pp. 148 - 150)

The number of individual teeth examined is given above each block.

A. PATIENTS WITH LIP REPAIR ONLY



B. PATIENTS WITH PALATE REPAIR ONLY



C. PATIENTS WITH BOTH LIP and PALATE REPAIRS

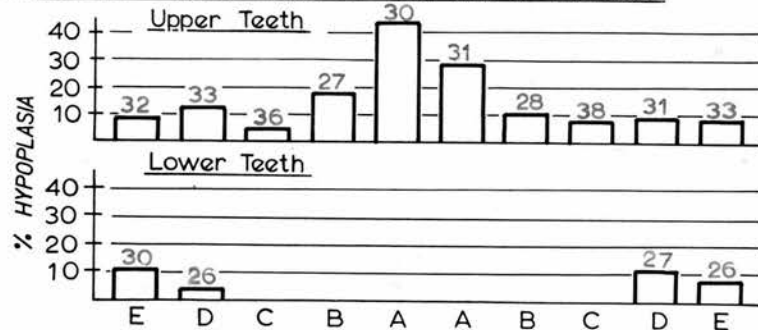


Fig. 22 - Histograms showing the relationship of enamel hypoplasia of deciduous teeth in patient study group to the surgery the patient has undergone (Tables XXXII, XXXIV, XXXVI, Appendix Pp.142, 144, 146

The number of individual teeth examined is given above each block.

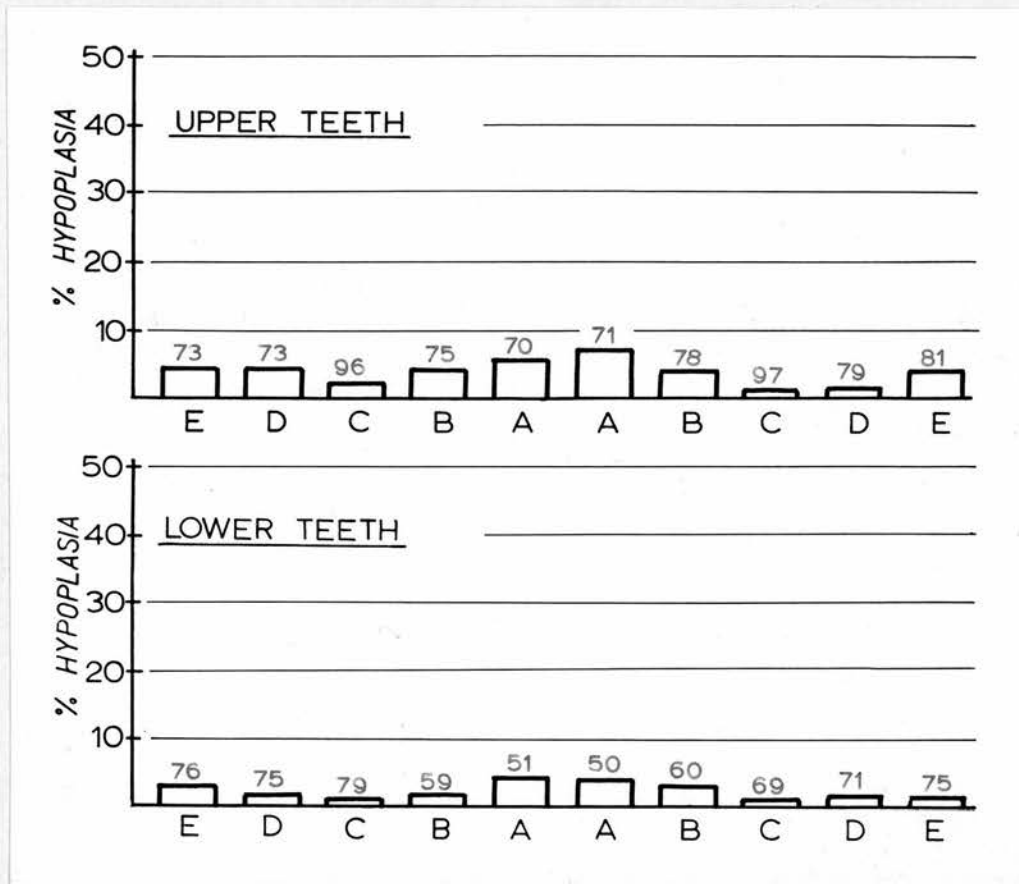


Fig. 23 - Histogram of enamel hypoplasia of deciduous teeth in control group of 100 normal children.

(Table XXIV; Appendix, p.123)

The number of individual teeth examined is given above each block



A



B

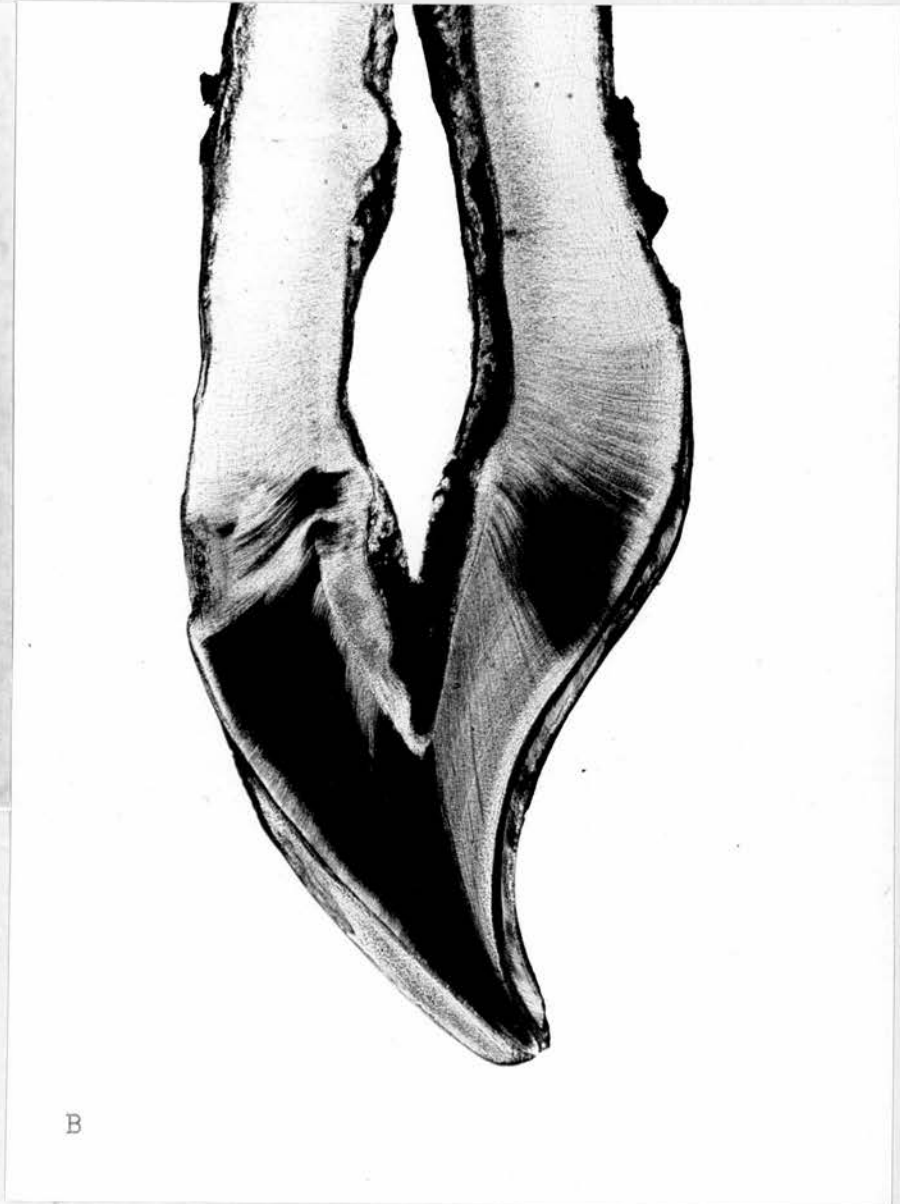
Fig. 24 -
Deciduous upper right central incisor

A, Labial surface (X5);

B, Histological ground-section (X7).



A



B

Fig.25 - Deciduous upper left central incisor

A, Labial surface (X5);

B, Histological ground-section (X7).



A



B

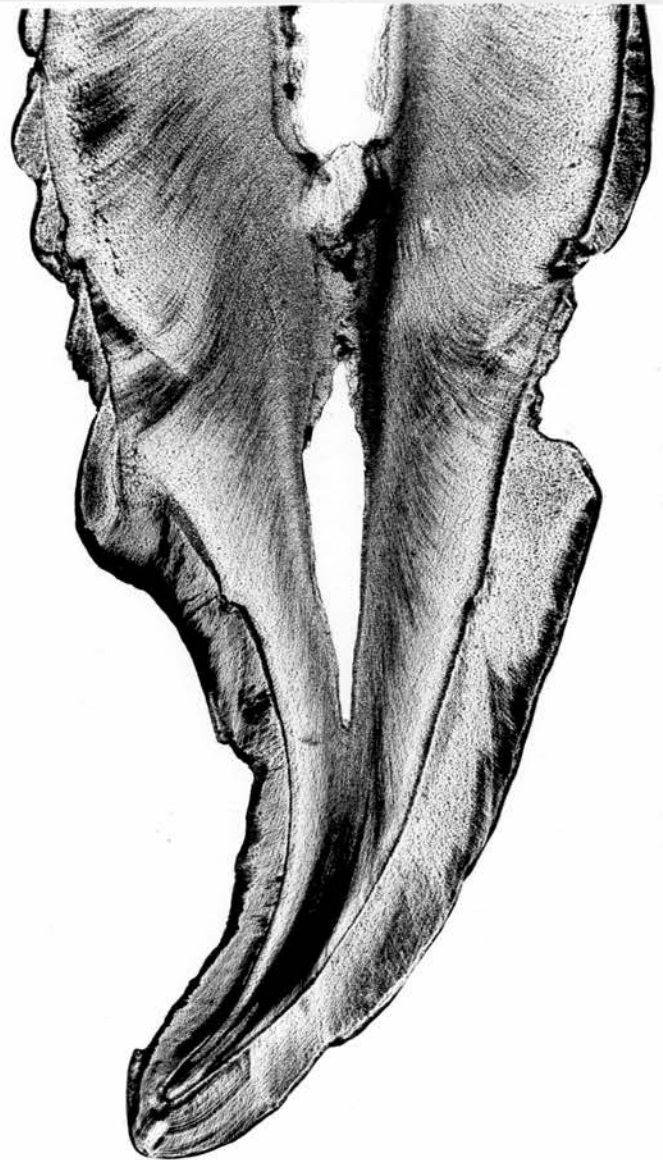
Fig.26 -
Permanent upper right central incisor (1 /)

A, Clinical photograph;

B, Histological ground-section (X12)



A



B

Fig. 27 - Permanent upper right central incisor (1 /).

A, Clinical photograph;

B, Histological ground-section (X12).

APPENDIX

SUPPLEMENTARY STUDY GROUPS

Control Group on Anodontia

Dental radiographs of 100 children from the Harpenden Growth Study Group at the Royal Dental Hospital, London, were examined. These were of normal children and the records were used as a control group for congenital absence of teeth in the cleft study group as no similar local group was available, and it was not considered justifiable to subject a further group of children to radiographic procedures for this purpose.

The radiographs were selected at random and equal numbers of each sex (50) were chosen. A number of radiographs were rejected to adjust the age of this group to a close approximation of that of the cleft study group as in Table XX.

Table XX

Age in Years	4	5	6	7
No. Examined	25	25	25	25

Total number of children 100. Mean age 5.5.

The group has therefore a slightly lower mean age than the patient study group. Any apparent absence of teeth such as premolars due merely to retarded development of a tooth will therefore be more marked in the control group than the study group.

The following instances of absence of premolar teeth were found in the control group:-

Table XXI

Age Group in Years	4	5	6	7
No. with absence of Premolar Teeth	4	1	1	2

Total number of children 100. Number showing absence of premolar teeth 8
(8 per cent)

The instances of absence of individual premolars is shown as follows:-

Table XXII

Individual Tooth Examined	5/	4/	4/	5/	5/	4/	4/	5/
No. of Instances of Absence Recorded	3	-	-	2	7	-	-	5

Total number of premolars absent 17.

The above tables show that the one-half of the patients showing absence of premolars were in the 4-year -old age group, and that the lower second premolar was the most frequent tooth absent.

Control Group for Enamel Hypoplasia

The incidence of enamel hypoplasia of the teeth in a normal series of children was obtained by clinical examination of 100 children from the Stockbridge Primary School, Edinburgh. The same criteria for enamel hypoplasia were used by the same observer as with the patient study group. The numbers of the control group were equally divided between the sexes and the age-range was as shown in Table XXII

Table XXIII

Age in Years	5	6	7
No. Examined	38	37	25

Total patients 100. Mean age 5.87

The group has therefore a similar mean age, but with a smaller age distribution than the patient study group.

Findings on Enamel Hypoplasia in Control Group of Children

As the age-range of the control group was more limited, only the deciduous teeth were examined and the findings are given in Table XXIV.

Table XXV (FIG.31)

Upper Deciduous Teeth

Individual Tooth	<u>E/</u>	<u>D/</u>	<u>C/</u>	<u>B/</u>	<u>A/</u>	<u>/A</u>	<u>/B</u>	<u>/C</u>	<u>/D</u>	<u>/E</u>
No. Teeth Examined	73	73	96	75	70	71	78	97	79	81
No. Teeth Hypoplastic	3	3	2	3	4	5	3	1	1	3
Per cent Hypoplastic	4.1	4.1	2.1	4	5.7	7	3.9	1	1.3	3.7

Lower Deciduous Teeth

Individual Teeth	<u>E/</u>	<u>D/</u>	<u>C/</u>	<u>B/</u>	<u>A/</u>	<u>/A</u>	<u>/B</u>	<u>/C</u>	<u>/D</u>	<u>/E</u>
No. Teeth Examined	76	75	95	59	51	50	60	93	71	75
No. Teeth Hypoplastic	2	1	1	1	2	2	2	1	1	1
Per cent Hypoplastic	2.8	1.3	1.1	1.7	4.0	4.0	3.3	1.1	1.4	1.3

Abnormalities in the Teeth of the Parents of Children with Cleft Palate

The opportunity was taken to examine the dentition of those parents who attended with their children for the purposes of this study. Altogether 85 parents were examined; 12 fathers and 73 mothers. Unfortunately, of this group 22 had full dentures and 27 had dentitions so mutilated by extractions that no conclusions could be made.

The remaining 36 parents had good dentitions. The following abnormalities were observed in the dentitions in 6 subjects, all of which were female (Table XXV).

Table XXV

Parent	Dental Abnormality
A	$\frac{5/5}{/5}$ absent
B	$\frac{1}{3}$ erupted labially
C	$\frac{1}{2}$ absent
D	$\frac{5}{5}$ absent
E	median spacing of $\frac{1}{1}$
F	$\frac{1/2}{5/5}$ absent (illustrated in Fig. 18)

It was not possible to radiograph all the parents dentitions, therefore only in those parents in which congenital absence of teeth was suspected by clinical examination, were radiographs taken. No record was made of anomalies of the third molars. Of these parents one only exhibited a cleft (left lip alveolar and palate), and she was edentulous. Parent C, in addition to the absence of an upper permanent lateral incisor, also exhibited a congenital lower lip fistula, a rare condition which is associated with cleft palate (Fogh-Anderson, 1953).

STATISTICAL METHODS AND RESULTS

Statistical Terminology and Methods

The findings of this study which could be tested statistically were subjected to the methods described by Bradford-Hill (1961). In line with common usage the term 'mean' is used to denote the average value, and 'mode' is the most frequent value in a grouped series.

The assessment of findings on the absence of premolar teeth and the incidence of enamel hypoplasia in the cleft study group was made in comparison with findings in comparable control groups of normal children. In groups exceeding 30 individuals, the method advocated by Bradford-Hill is to obtain the standard error of the difference (SE of D) between two means and to compare it with the difference between the two means.

The formula for the SE of D

$$= \sqrt{\frac{p1 \times q1}{n1} + \frac{p2 \times q2}{n2}}$$

The groups of observations are calculated separately and the square root taken. If the difference in percentage of the incidence of the two groups is greater than twice the standard error of the difference, this difference was considered unlikely to have arisen by chance and is termed significant. The levels of significance in this test are at 2 (5 in 100 tests), at $2\frac{1}{2}$ (1 in 80 tests) and at 3 (1 in 370 tests).

M = Mean value

X = Individual observations

n = Number of observations

p = Findings expressed in percentage

q = Percentage in other category than findings

Analysis of Findings on Absence of Premolar teeth

The patients in cleft study totalled 76 and of these 20 showed absence of premolars giving an incidence of 26.3 per cent. In the control group of 100 patients the incidence was 8 per cent. Therefore, the percentage difference between the two groups was 18.3 per cent and the SE of D can be calculated as

$$\sqrt{\frac{26.3 \times 73.7}{76} + \frac{8 \times 92}{100}} = 5.7$$

It may therefore be stated that the percentage difference between the two groups was 3.9 ($18.3 \div 5.7$) times the SE of D of the two groups and a significant difference was obtained.

Analysis of Enamel Hypoplasia

For the purpose of this analysis the deciduous teeth examined in the patient study group and the control group were grouped into molars, canines, and incisors of each arch. These findings can be tabulated in Table XXVI for the patient study group and Table XXVII for the control group.

Table XXVI

Tooth Grouping	Upper Teeth			Lower Teeth		
	Incisors	Canines	Molars	Incisors	Canines	Molars
Teeth examined	224	139	236	211	139	210
Per cent hypoplastic	18.3	7.2	8.5	3.8	2.2	8.6

Table XXVII

Tooth Grouping	Upper Teeth			Lower Teeth		
	Incisors	Canines	Molars	Incisors	Canines	Molars
Teeth examined	294	193	306	220	188	297
Per cent hypoplastic	5.1	1.5	3.1	3.2	1.1	1.7

The distribution of teeth examined in the patient study group and the control group was similar as shown in

Table XXVIII

Table XXVIII

Distribution of Teeth	Incisors	Canines	Molars
Upper teeth in cleft group	19.3	12.0	20.3
Upper teeth in control group	19.6	12.9	20.4
Lower teeth in cleft group	18.1	12.0	18.2
Lower teeth in control group	14.7	12.5	19.8

The only difference of any degree shown is between the lower deciduous incisors of both groups with a difference of 3.4 per cent. Therefore, it is permissible to undertake a statistical analysis of the incidence of enamel hypoplasia using the above groupings. The results of this analysis are given in Table XXIX .

Table XXIX

Group of Teeth	Upper Teeth			Lower Teeth		
	Incisors	Canines	Molars	Incisors	Canines	Molars
Incidence in cleft group	18.3	7.2	8.5	3.8	2.2	8.6
Incidence in control group	5.1	1.5	3.1	3.2	1.1	1.7
difference between groups	13.2	5.7	5.4	.8	1.1	5.9
SE of D	3	2.3	2.1	1.6	1.4	2.2
'T' value	4.4	2.5	2.6	0.5	0.8	2.7

A significant difference between the incidence of enamel hypoplasia of the deciduous incisors, canines and molars and the lower deciduous molars of the cleft study group and the control group was established. The findings on the deciduous lower incisors and canines were not significant.

ACCURACY OF OBSERVATIONS

1. Tooth Number

The study casts and radiographs taken of each patient were re-examined. A discrepancy with the first examination was resolved by obtaining a second opinion from the Lecturer in Dental Radiography at Edinburgh University.

2. Tooth Form

The analysis of tooth form was based entirely on the assessment of this feature by the single observer.

3. Enamel Hypoplasia

The re-examination of a number of the children studied was possible when they were recalled in the summer of 1961 by the Child Life and Health Department of Edinburgh University for the purpose of a genetic investigation into the aetiology of cleft palate. The following 10 children were re-examined (Patient Record Nos. 4, 7, 18, 23, 27, 40, 45, 64, 67, 75) and no discrepancy occurred in this small series with the findings of the initial examination, except that caused by loss or extraction of deciduous teeth or further eruptions.

DETAILED DESCRIPTION OF MORPHOLOGY
OF COLLECTION OF LATERAL INCISORS

SPECIMEN 1. Fig. 7 Left permanent lateral incisor from mesial cleft margin.

SIZE Overall length 20mm, maximum width crown 8mm.

GENERAL DESCRIPTION The crown is angled mesially and palatally to the long axis of the tooth. The incisal surface presents three mammelons, and slopes distally merging with the distal surface which is convex. The labial surface exhibits transverse ridging of the enamel and there are hypoplastic areas on all surfaces of the crown. The general appearance and size of the tooth is that of a deformed central incisor.

GROUND SECTION The thickness of the root is well seen together with a correspondingly wide pulp chamber to the wall of which a large pulp stone is attached. There is a greater than usual crown root angle and the crown appears short. This is due to a deficiency of enamel in the region of the amelocemental junction. The enamel at the tip is poorly formed and without a regular incremental pattern. A very thin layer of enamel, with the prisms set at a different angle to the underlying enamel, caps the upper third of the crown. The dentine shows a marked incremental line dividing off the upper half of the crown. The nature of the defective structure indicates a developmental disturbance during the first 3 years of the formation of this tooth.

SPECIMEN 2. Fig. 8 Left permanent lateral incisor from the distal margin of a cleft.

SIZE Length 22mm, maximum width crown 5.5mm.

GENERAL DESCRIPTION Conical with three incisal cusps with the central one well developed. The lateral cusps are joined to the cingulum by well developed marginal ridges. A deep pit is present between the cingulum and the central cusp. The labial surface is round and the enamel margin is straight. Classified as a Group VI form.

GROUND SECTION The root is long for a lateral incisor, but otherwise normal in structure. The crown is elevated buccally and lingually and with a central deep enamel fissure. The fissure penetrates almost to the dentine but is separated from it by a small plug of enamel. There is also a small infolding of the enamel at the tip of the buccal cusp. The dental tissues are well formed in this section.

SPECIMEN 3. Fig. 9 Right permanent lateral incisor from
medial side of cleft. (2W/)

SIZE Length 16mm, maximum width crown 5mm.

GENERAL DESCRIPTION Cone shaped tooth with pit at tip of
cusp. Hypoplastic pit palatally. Short curved labial
surface with curved enamel margin. Group 1 form.

GROUND SECTION The root is normally formed but with a
thick layer of cementum.

A cone shaped form with a small enamel invagination at
the tip with a small bare area of dentine. The enamel
shows a number of well marked lamellae and at one area
on the palatal surface a section of enamel has broken
away along the lamellar lines.

The dentine is relatively normal.

SPECIMEN 4. Fig. 10 Permanent right lateral incisor on
distal side of cleft margin. (2D/)

SIZE Length 16mm, maximum width crown 6mm.

GENERAL DESCRIPTION Blunted cone with a high cingulum
separated from the incisal edge by a shallow pit.

Colyer Group IV form.

Enamel hypoplasia on the mesial surface.

GROUND SECTION A tooth with a curved root and a blunt
crown with a large cingulum.

The enamel has an irregular surface formation especially
over the cusps. An infolding or invagination of the
enamel is present in the base of the coronal fissure.
This is apparently a minor form of dens invaginalis,
with the infolding limited to the enamel and with the
dentine showing no abnormalities.

SPECIMEN 5. Fig. 11 Permanent left lateral incisor from the distal side of cleft margin.

SIZE Length 14mm, maximum width crown 5.5 mm.

GENERAL DESCRIPTION Labial surface well rounded, the incisal surface is divided into two by a central cusp. Both the mesial and distal surfaces of the crown converge towards the long axis of the tooth. The lingual surface has a rounded cingulum but no lingual fossa. Enamel hypoplasia upper third of the crown is present together with a pit on the lingual surface. There is a tendency for this tooth to resemble a canine in form.

GROUND SECTION The root apex is missing and appears to have been broken off probably when the tooth was extracted. A tooth with a rather thick root and crown for a lateral incisor. Severe enamel hypoplasia is present in the upper half of the lingual surface of the crown.

The dentine is relatively normal with little secondary dentine formation.

SPECIMEN 6. Fig. 12 Deciduous left lateral incisor from the distal side of the cleft margin.

SIZE Overall length 18mm, maximum width crown 5.5mm.

GENERAL DESCRIPTION An unusual tuberculated crown form. The incisal edge comes to a central point and slopes away mesially and distally meeting the mesial and distal margins at definite angles. The lingual surface is dominated by a large cingulum from which a median ridge rises to the central point on the incisal margin. The enamel is poorly formed on all surfaces of the crown. The root is long and curved near the apex. May be considered as a Colyer Group IV form.

GROUND SECTION The enamel formed after first incremental line is very defective and areas of enamel appear to have broken away resulting in surface caries. The resultant deficiencies in enamel are repaired by areas secondary dentine laid down at the cornu of the pulp. A long distally curved root, with no histological abnormalities.

SPECIMEN 7. Fig. 13 Deciduous left upper lateral incisor
from distal side of cleft.

SIZE Length 12mm, maximum width of crown 5.5 mm.

GENERAL DESCRIPTION The incisal surface is formed into two lobes by a furrow extending on both labial and palatal surfaces and forming a large mesial cusp and smaller distal cusp. On the lingual surface the furrow ends in a pit just above the cingulum. There is an enamel hypoplastic area on the mesial surface. Group II form.

SPECIMEN 8. Fig. 14 Upper left permanent lateral from distal side of cleft.

SIZE Length 20mm, maximum width of crown 6mm.

GENERAL DESCRIPTION Rounded labial surface with the incisive surface divided into a mesial and distal incline. Well formed cingulum with central fossa on palatal surface. Enamel the mesial and distal surfaces. The root is flattened mesio-distally with central groove. The tooth is relatively normal in appearance as a lateral incisor, however a tendency of the incisal surface to slope from a central point in a canine may be noted.

SPECIMEN 9. Fig. 15 Deciduous left lateral incisor from distal cleft margin.

SIZE Length 15mm, maximum width crown 5mm.

GENERAL DESCRIPTION The incisal margin has indication of mammelons. The central mammelon is joined by a slight ridge traversing the lingual surface from the cingulum. In other respects the tooth is typical of a deciduous lateral incisor except for hypoplastic areas on the lingual and labial surfaces. It may be considered as a tooth with a mild tendency to a Goyler Group IV abnormality.

SPECIMEN 10. Fig. 16 Deciduous left lateral incisor from distal margin of cleft.

SIZE Length 9mm, maximum width crown 6mm.

GENERAL DESCRIPTION Two thirds of the root of this tooth have been resorbed. The crown is thick and bulbous. The incisive margin slopes mesially and distally from a central cusp. The cingulum is well marked and there is an indication of a median ridge on the lingual surface. The labial surface is well rounded and the medial and distal marginal ridges on the lingual surface are well marked. This tooth is similar in outline to a deciduous canine except in respect of the development of the cingulum.

TABULATION OF ENAMEL HYPOPLASIA

TABLE XXX FIG. 19 Enamel hypoplasia in deciduous dentition

The incidence of enamel hypoplasia in the 76 patients examined is tabulated. Supernumerary teeth are not included in the tooth count.

Upper teeth.	<u>E/</u>	<u>D/</u>	<u>C/</u>	<u>B/</u>	<u>A/</u>	<u>/A</u>	<u>/B</u>	<u>/C</u>	<u>/D</u>	<u>/E</u>
Teeth examined	59	59	68	55	56	55	58	71	58	59
No. hypoplastic	5	6	4	7	15	12	7	6	5	4
% hypoplastic	8.5	10.2	5.9	12.7	26.8	21.8	12.1	8.5	8.6	6.9

Lower teeth.	<u>E/</u>	<u>D/</u>	<u>C/</u>	<u>B/</u>	<u>A/</u>	<u>/A</u>	<u>/B</u>	<u>/C</u>	<u>/D</u>	<u>/E</u>
Teeth examined	54	51	69	57	50	51	57	68	52	50
No. hypoplastic	4	6	2	2	2	2	2	1	5	3
% hypoplastic	7.4	11.5	2.9	3.6	4.1	4	3.6	1.4	9.4	5.9

A histogram of the above table is shown in Fig. 19.

Enamel hypoplasia in permanent dentition in 76 patients

TABLE XXXI FIG. 20

Upper teeth	<u>6/</u>	<u>5/</u>	<u>4/</u>	<u>3/</u>	<u>2/</u>	<u>1/</u>	<u>/1</u>	<u>/2</u>	<u>/3</u>	<u>/4</u>	<u>/5</u>	<u>/6</u>
Teeth examined	31	1	2	1	5	19	16	3	2	2	-	30
No. hypoplastic	2	-	-	-	-	10	8	2	-	-	-	3
% hypoplastic	6.4	-	-	-	-	52.6	50	66.6	-	-	-	10

Lower teeth	<u>6/</u>	<u>5/</u>	<u>4/</u>	<u>3/</u>	<u>2/</u>	<u>1/</u>	<u>/1</u>	<u>/2</u>	<u>/3</u>	<u>/4</u>	<u>/5</u>	<u>/6</u>
Teeth examined	32	-	-	2	17	21	19	16	3	-	-	31
No. hypoplastic	2	-	-	-	-	1	1	1	-	-	-	3
% hypoplastic	6.2	-	-	-	-	4.8	5.3	6.2	-	-	-	9.6

Enamel hypoplasia in patients with lip repair only

Of the 76 patients examined 13 had required only operative repair of the lip. (Patients No's 4, 19, 21, 24, 25, 29, 35, 41, 56, 62, 66, 68, 71.)

Finding in the deciduous dentition.

TABLE XXXII Fig.22.

Upper teeth	<u>E/</u>	<u>D/</u>	<u>C/</u>	<u>B/</u>	<u>A/</u>	<u>/A</u>	<u>/B</u>	<u>/C</u>	<u>/D</u>	<u>/E</u>
Teeth examined	12	13	12	11	9	9	12	13	13	11
No. hypoplastic	-	-	-	1	2	2	1	-	-	-
% hypoplastic	-	-	-	9.1	22.2	22.2	8.3	-	-	-

Lower teeth	<u>E/</u>	<u>D/</u>	<u>C/</u>	<u>B/</u>	<u>A/</u>	<u>/A</u>	<u>/B</u>	<u>/C</u>	<u>/D</u>	<u>/E</u>
Teeth examined	9	10	13	9	9	9	9	13	11	10
No. hypoplastic	1	1	-	-	-	-	-	-	-	-
% hypoplastic	11.1	10	-	-	-	-	-	-	-	-

Enamel hypoplasia in permanent dentition
in patients with lip repair only

TABLE XXXIII.

Upper teeth	6/	5/	4/	3/	2/	1/	/1	/2	/3	/4	/5	/6
Teeth examined	5	-	-	-	1	4	4	-	-	-	-	5
No. hypoplastic	-	-	-	-	-	3	1	-	-	-	-	-

Lower teeth	6/	5/	4/	3/	2/	1/	/1	/2	/3	/4	/5	/6
Teeth examined	5	-	-	-	3	4	4	2	-	-	-	5
No. hypoplastic	-	-	-	-	-	1	-	-	-	-	-	-

The % incidence of hypoplasia is not given in the tables
as the samples are too small.

Enamel hypoplasia in patients with palate repair only

20 patients had required palate repair only (Patient No's 6, 8, 12, 18, 20, 27, 28, 32, 33, 34, 44, 45, 50, 52, 58, 59, 61, 70, 72, 75.)

Findings in the deciduous dentition

TABLE XXXIV FIG.22.

Upper teeth	E/	D/	C/	B/	A/	/A	/B	/C	/D	/E
Teeth examined	15	13	20	17	17	16	18	20	14	15
No. hypoplastic	2	2	2	1	-	1	2	3	2	1
% hypoplastic	14.4	15.4	10	5.9	-	6.5	11.1	15	14.3	7.2

Lower teeth	E/	D/	C/	B/	A/	/A	/B	/C	/D	/E
Teeth examined	15	15	20	17	14	14	18	18	14	14
No. hypoplastic	2	-	4	2	2	2	2	1	2	-
% hypoplastic	-	28.8	10	11.8	14.3	14.3	11.1	5.6	14.3	-

Findings in the permanent dentition

TABLE XXXV.

Upper teeth	6/	5/	4/	3/	2/	1/	/1	/2	/3	/4	/5	/6
Teeth examined	8	-	-	-	1	2	2	-	-	-	-	7
No. hypoplastic	1	-	-	-	-	-	-	-	-	-	-	1

Lower teeth	$\overline{6/}$	$\overline{5/}$	$\overline{4/}$	$\overline{3/}$	$\overline{2/}$	$\overline{1/}$	$\overline{/1}$	$\overline{/2}$	$\overline{/3}$	$\overline{/4}$	$\overline{/5}$	$\overline{/6}$
Teeth examined	7	-	-	-	2	3	3	2	-	-	-	5
No. hypoplastic	1	-	-	-	-	-	-	-	-	-	-	1

The % incidence of enamel hypoplasia is not given as the samples are too small.

Findings in the permanent dentition

TABLE XXXVII

Upper teeth	<u>6/</u>	<u>5/</u>	<u>4/</u>	<u>3/</u>	<u>2/</u>	<u>1/</u>	<u>/1</u>	<u>/2</u>	<u>/3</u>	<u>/4</u>	<u>/5</u>	<u>/6</u>
Teeth examined	18	1	2	1	3	13	10	3	2	2	-	18
No. hypoplastic	1	-	-	-	-	7	7	2	-	-	-	2
% hypoplastic	5.5	-	-	-	-	54	70	67	-	-	-	11

Lower teeth	<u>6/</u>	<u>5/</u>	<u>4/</u>	<u>3/</u>	<u>2/</u>	<u>1/</u>	<u>/1</u>	<u>/2</u>	<u>/3</u>	<u>/4</u>	<u>/5</u>	<u>/6</u>
Teeth examined	20	-	-	2	12	14	13	12	3	-	-	21
No. hypoplastic	1	-	-	-	-	-	1	1	-	-	-	2
% hypoplastic	5.1	-	-	-	-	-	7.7	8.3	-	-	-	9.5

Enamel hypoplasia of the upper anterior
teeth related to the cleft side.

9 Patients with right sided lip clefts totalled 20. (Patient No's 3, 4, 5, 10, 17, 19, 23, 24, 29, 31, 36, 38, 39, 54, 56, 62, 66, 67, 69, 76.)

TABLE XXXVIII FIG. 21.

Deciduous teeth	<u>C/</u>	<u>B/</u>	<u>A/</u>	<u>/A</u>	<u>/B</u>	<u>/C</u>
Teeth examined	18	13	14	15	19	19
No. hypoplastic	1	4	10	-	-	-
% hypoplastic	5.5	30.7	71.5	-	-	-

Permanent teeth	<u>3/</u>	<u>2/</u>	<u>1/</u>	<u>/1</u>	<u>/2</u>	<u>/3</u>
Teeth examined	3	2	6	4	1	-
Teeth hypoplastic	-	-	6	-	1	-

Patients with left sided lip clefts totalled 22 (Patient No's 1, 2, 7, 9, 15, 21, 25, 30, 37, 40, 41, 42, 43, 47, 51, 53, 55, 57, 60, 63, 71, 73.)

TABLE XXXIX. FIG.21.

Deciduous teeth	C/	B/	A/	/A	/B	/C
Teeth examined	19	18	17	16	15	21
No. hypoplastic	1	1	2	8	2	1
% hypoplastic	5.2	5.5	11.7	50	14.4	4.8

Permanent teeth	3/	2/	1/	/1	/2	/3
Teeth examined	1	4	5	5	1	1
No. hypoplastic	-	-	-	5	1	-

Patients with bilateral lip clefts totalled 14. (Patient No's 11, 13, 14, 16, 22, 26, 35, 47, 48, 49, 53, 64, 65, 74.)

TABLE XL FIG. 21.

Deciduous teeth	<u>C/</u>	<u>B/</u>	<u>A/</u>	<u>/A</u>	<u>/B</u>	<u>/C</u>
Teeth examined	11	7	8	8	6	11
No. hypoplastic	-	1	3	3	3	2
% hypoplastic	-	14.3	37.5	37.5	50	18.21

Permanent teeth	<u>3/</u>	<u>2/</u>	<u>1/</u>	<u>/1</u>	<u>/2</u>	<u>/3</u>
Teeth examined	-	-	6	5	1	1
No. hypoplastic	-	-	4	3	-	-

These tables are given in histogram form for the deciduous teeth in Fig. 21.

Individual Patient Records

The details recorded from the examination of each patient are listed. The following abbreviations are utilized to simplify the presentation.

- b. = date of birth.
- L. = date of lip repair.
- P. = date of palate repair.
- TP. = teeth present and erupted at date of examination for hypoplasia.
- 123^{*} = enamel hypoplasia of a tooth is denoted by an associated star.
- MA. = The morphological abnormalities of the teeth.
- CR. = Relationship of cleft to teeth of upper labial segment.
- // = The position of an alveolar cleft to the teeth.
- bM. = A deciduous lateral on mesial cleft margin.
- bD. = A deciduous lateral on distal cleft margin.
- 2M. = A permanent lateral on mesial cleft margin.
- 2D. = A permanent lateral on distal cleft margin.

1. JA Male, b. 6/50. L. 12/50. P. 2/55.
Left lip alveolar palate cleft.
TP (5/58)

	Deciduous	Permanent
	$\frac{ed/bcde}{edc/cde}$	$\frac{621/16}{621/126}$
CR	c b a a // bD c	3 2 1 1 // 2D 3
MA		/2D conical.

2. EA Male, b. 8/51. L. 1/52. P. 11/52.
Left lip alveolar palate cleft.
TP (7/59)

	Deciduous	Permanent
	$\frac{ecb/bcde}{ec/c}$	$\frac{61/126}{621/126}$
CR	c b a a // bD c	3 2 1 1 2M // 2D 3
MA		/2D small conical form.

3. RA Female, b. 5/51. L. 11/51. P. 5/53.
Right lip alveolar palate cleft.
TP 4/60

	Deciduous	Permanent
	$\frac{/abc}{c}$	$\frac{61/6}{621/126}$
CR	c bD // a a b c	3 // 11 2 3
TA		5/5

4. DB Male, b. 9/54. L. 11/54.
Right lip alveolar cleft.
TP 6/59

	Deciduous	Permanent
	$\frac{edcba/abcde}{edcba/abcde}$	
CR	c bD // a a b c	3 2D // 1 1 2 3
MA		/2 conical 2D/ Group III form.

5. DB Male, b. 12/54, L. 3/55. P. 4/56
Right lip alveolar palate cleft.
TP 2/60

	Deciduous	Permanent
	$\frac{edca}{edcba} / \frac{abcde}{abcde}$	
CR	c // a a b c	3 2D // 1 1 2 3
TA		$\frac{5}{5}$
MA	$\angle D$ paramolar cusp	$\underline{2D}$ conical form

6. PB Female, b. 3/54. P. 9/55.
Post alveolar cleft.
TP 8/60

Deciduous	Permanent
$\frac{e cb}{edcba} / \frac{bcd}{abcde}$	$\frac{61/16}{6/6}$

7. GB Male, b. 6/53. L. 2/54. P. 7/54.
Left lip alveolar palate cleft.
TP 6/59

	Deciduous	Permanent
	$\frac{*edoba}{cba} / \frac{*abcd}{abcd}$	
CR	c b a a // bD c	3 1 1 // 2D 3
TA		$\frac{2}{2}$
OA	$\angle bD$ Group \overline{IV} form.	$\angle 2D$ small conical form

8. HB Female, b. 5/54. P. 11/55.
Post alveolar cleft.
TP 2/60

Deciduous	Permanent
$\frac{cba}{ecba} / \frac{abce}{abce}$	

9. HB Female, b. 11/54. L. 3/55. P. 3/56.
Left lip alveolar palate cleft.
TP 11/60

Deciduous	Permanent
$\frac{edcba}{edcba} / \frac{a}{abcde}$	$\frac{6}{6} / \frac{6}{6}$

CR c b a a // c 3 2 1 1 // 3

10. JC Male, b. 6/55. L. 10/55. P. 12/56.
Right lip alveolar palate cleft.
TP 6/60

Deciduous	Permanent
$\frac{edcba}{cba} / \frac{abcde}{abc}$	$\frac{6}{6}$

CR c b D // a a b c 3 2 D // 2M 1 1 2 3

11. JC Female, b. 1/50. L. 6/50. P. 4/52.
Bilateral lip alveolar palate cleft.
TP. 11/59

Deciduous	Permanent
$\frac{cb}{dc} / \frac{bc}{c}$	$\frac{6^*}{521} / \frac{1^*}{126}$

CR c b D // bM a a bM // bD c 3 // 2M 1 1 2M // 3

MA 2M retarded development.

bM central incisor form.
bM Group VII type with extra cusp on distal surface.
bD Small caniniform form.
(Deciduous incisor forms illustrated in Fig. 11A)

12. DC Male, b. 9/55. P. 3/57.
Post alveolar cleft.
TP 8/60

Deciduous	Permanent
$\frac{edcba}{edcba} / \frac{abcde}{abcde}$	

13. RE Male, b. 5/53. L. 9/53. P. 10/54.
Bilateral lip alveolar palate cleft.
TP 2/61

	Deciduous	Permanent
	$\frac{edc/acde}{ed/c e}$	$\frac{61/6}{621/126}$
CR	c bD // a a // bD c	3 2D // 1 1 // 2D 3
MA		$\frac{2D}{2D}$ conical forms /6 delayed calcification

14. RF Male, b. 3/52. L. 7/52. P. 1/54.
Bilateral lip alveolar palate cleft.
TP 11/59

	Deciduous	Permanent
	$\frac{ec/c}{ec/c}$	$\frac{651/16}{621/126}$
CR	c bD // a a // bD c	3 2D // 1 1 // 2D 3
MA		$\frac{2D}{2D}$ small invaginated conical forms.

15. CF Female, b. 3/50. L. 7/50. P. 9/50.
Left lip alveolar palate cleft.
TP 1/60

	Deciduous	Permanent
	$\frac{edc/cde}{edc/cde}$	$\frac{621/16}{621/126}$
CR	c b a a // bD c	3 2 1 1 // 3
TA		$\frac{5/}{5/5}$
MA	/bD caniniform	1/ dichotomous form (illustrated in Fig. 25 D)

16. AF Male, b. 7/51. L. 4/52. P. 6/52.
Bilateral lip, left alveolar and palate cleft.
TP 10/59

	Deciduous	Permanent
	$\frac{*}{*} \frac{edcba}{cde}$ $\frac{e}{c} / \frac{de}{de}$	$\frac{6}{6} \frac{1}{1} \frac{1}{1} \frac{6}{6}$ $\frac{621}{1236}$
CR	c b a a // bD c	3 2 1 1 // 2D 3
MA	b/ Group <u>IV</u> form.	<u>2D</u> conical invaginated form. <u>2/</u> conical form <u>1/</u> retarded development. (illustrated in Fig. 25 A)

17. JF Male, b. 5/53. L. 7/53. P. 10/54.
Right lip alveolar palate cleft.
TP 4/60

	Deciduous	Permanent
	$\frac{*}{*} \frac{cba}{abc}$ $\frac{cb}{abc}$	$\frac{6}{6} / \frac{6}{6}$ $\frac{61}{6}$
CR	c bD // a a b c	3 2D // 1 1 2 3
MA	<u>a</u> dichotomous form	

18. SF Female, b. b. 2/57. P. 4/58.
Post alveolar cleft.
TP 3/61

	Deciduous	Permanent
	$\frac{dcba}{cb} / \frac{abce}{bcd}$	
MA		<u>2/</u> conical form (illustrated in Fig. 25 B)

19. GF Female, b. 7/54. L. 2/55.
Right lip and alveolar cleft.
TP 6/60

	Deciduous	Permanent
	$\frac{edcba}{edcba} / \frac{abcde}{abcde}$	
CR	c bD // a a b c	3 // 1 1 3
TA		<u>2</u>
MA	bD/large transitional form.	

20. SG Female, b. 10/54. P. 7/60.
Post alveolar cleft.
TP 6/60

Deciduous	Permanent
<u>edba</u> / <u>abcde</u>	<u>6</u> /
<u>edcba</u> / <u>abcde</u>	

21. BG Male, b. 5/55. L. 10/55.
Left pre-alveolar cleft.
TP 6/60

Deciduous	Permanent
<u>edcba</u> / <u>abcde</u>	
<u>edcba</u> / <u>abcde</u>	

CR	c b a a b e	3 2 1 1 2 3
MA	<u>/p</u> Group <u>IV</u> form	<u>/2</u> larger than normal.

(Deciduous incisor form illustrated in Fig. 10 B)

22. CG Male, b. 2/49. L. 6/49. P. 7/50.
Bilateral lip cleft, right alveolar and palate.
TP 7/59

Deciduous	Permanent
	<u>* *</u>
	<u>6 1</u> / <u>12346</u>
	<u>6321</u> / <u>123 6</u>

CR	c bD // bM a a bM bD c	3 2D // 2M 1 1 // 2M 2D 3
MA	<u>bM/bM</u> central incisor form.	<u>2M</u> conical form. <u>/2M</u> central incisor form. <u>2D/2D</u> Group <u>VI</u> form

(Incisor form illustrated in Fig. 11 C)

23. DG Male, b. 11/53. L. 2/54. P. 3/55.
Right lip alveolar palate cleft.
TP 3/59

Deciduous	Permanent
<u>** edcba</u> / <u>abcde</u>	
<u>** edcba</u> / <u>abcde</u>	

CR	c bD // a a b c	3 // 1 1 2 3
----	-----------------	--------------

24. CH Female, b. 4/53. L. 7/53.
Right lip alveolar and palate cleft.
TP 8/59

	Deciduous	Permanent
	$\frac{edcb/bcde}{edc/cde}$	$\frac{6^*/1^*6}{6^*1^*6}$
CR	c bD // a a b c	3 2D // 1 1 2 3
MA		<u>2D</u> / conical form.

(Note: The palate cleft was of a submucous type and no palate operation was undertaken.)

25. HH Female, b. 12/49. L. 6/50.
Left lip and alveolar cleft.
TP 11/59

	Deciduous	Permanent
	$\frac{ed/cde}{cc/cde}$	$\frac{621^*/1^*6}{621^*/126}$
CR	c b a a // bD c	3 2 1 1 // 2D 3

26. JH Male, b. 11/51. L. 2/52. P. 6/53.
Bilateral lip, alveolar and palate cleft.
TP 1/60

	Deciduous	Permanent
	$\frac{a^*/a^*}{cb/bc}$	$\frac{6}{6 \ 21/12 \ 6}$
CR	c bD // a a bM // bD c	3 2D // 1 1 2M // 2D 3
MA	<u>bM</u> central form	<u>2M</u> central form.

27. MH Female, b. 5/55. P. 3/59.
Post alveolar cleft.
TP 9/59

	Deciduous	Permanent
	$\frac{edcba/abcde}{edcba/abcde}$	
CR	c b a a b c	3 2 1 1 2 3
TA		<u>5/5</u>

28. IJ Male, b. 8/56. P. 11/57.
Post alveolar cleft.
TP 1/61

	Deciduous	Permanent
	$\frac{cba}{cb} / \frac{abc}{bc}$	
CR	c b a a b c	3 2 1 1 2 3
TA		$\frac{5}{5}$

29. AJ Male, b. 7/50. L. 12/50.
Right lip and alveolar cleft.
TP 8/58

	Deciduous	Permanent
	$\frac{edcb}{edc} / \frac{bode}{ode}$	$\frac{6^*1}{621} / \frac{16}{126}$
CR	c bD // a a b c	3 // 1 1 2 3

(Mesiodens present in permanent dentition.)

MA	$\frac{2}{2}$ dens invaginalis (illustrated in Fig. 25 C)
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30. BJ Male, b. 12/56. L. 3/57. P. 1/59.
Left lip alveolar palate cleft.
TP 2/61

	Deciduous	Permanent
	$\frac{edcba^*}{edcba} / \frac{abode^*}{abode}$	
CR	c b a a // bD c	3 2 1 1 // 2D 3
MA		$\frac{2}{2}$ conical form.

31. DJ Male, b. 8/56. L. 12/56. P. 2/58.
Right lip alveolar palate cleft.
TP 8/60

	Deciduous	Permanent
	$\frac{ecdab}{edcba} / \frac{abede}{abcd}$	
CR	c bD // a a b c	3 2D // 1 1 2 3

32. WK Female, 10/53. P. 6/56.
Post alveolar cleft.
TP 10/58

	Deciduous	Permanent
	$\frac{edca}{cba} / \frac{aod}{abc}$	$\frac{6}{6} / \frac{6}{6}$
CR	c b a a b c	3 2 1 1 2 3
TA		<u>54/5</u>

33. BL Male, b. 12/52. P. 1/54.
Post alveolar cleft.
TP 11/60

	Deciduous	Permanent
	$\frac{edcba}{edcba} / \frac{abcde}{abcde}$	$\frac{6}{6} / \frac{6}{6}$
CR	c b a a b c	3 2 1 1 2 3

34. EL Male, b. 4/56. P. 11/57.
Post alveolar cleft.
TP 11/60

	Deciduous	Permanent
	$\frac{edcba}{edcba} / \frac{abcde}{abcde}$	
CR	c b a a b c	3 2 1 1 2 3

35. AL Male, b. 3/50. L. 9/50.
Bilateral lip, left alveolar cleft.
TP 10/58

	Deciduous	Permanent
	$\frac{edcba}{edcba} / \frac{**abbode}{abcde}$	$\frac{6}{6} / \frac{6}{6}$
CR	c b a a bM // bD c	3 2 1 1 2M // 2D 3
OA	<u>/bM</u> central form	<u>/2M</u> twisted central form.

36. JL Male, b. 9/53. L. 2/54. P. 3/55.
Right lip alveolar palate cleft.
TP 10/59

	Deciduous	Permanent
	$\begin{array}{c} * \\ \text{edcba} / \text{abcde} \\ \text{edcba} / \text{abcd} \end{array}$	$\frac{6}{6}$
CR	c bD // bM a a b c	3 2D // 2M 1 1 2 3
TA		$\frac{5}{5} / \frac{5}{5}$
MA		$\frac{2D}{2M} / \text{conical.}$ $\frac{2M}{2M} / \text{Group III form}$

37. LL Female, b. 8/55. L. 1/56. P. 1/57.
Left lip alveolar and palate cleft.
TP 8/60

	Deciduous	Permanent
	$\begin{array}{c} \text{edcba} / \text{acde} \\ \text{edcba} / \text{abcde} \end{array}$	
CR	c b a a // bD c	3 2 1 1 // 3

38. DMcA Male, b. 12/54. L. 4/55. P. 11/56.
Right lip alveolar palate cleft.
TP 12/58

	Deciduous	Permanent
	$\begin{array}{c} ** \\ \text{edcba} / \text{abcde} \\ \text{edcba} / \text{abcde} \end{array}$	
CR	c bD // bM a a b c	3 // 1 1 2 3
MA	$\frac{bM}{bM} / \text{central form}$	

39. SMCB Female, b. 9/53. L. 2/54. P. 2/55.
Right lip alveolar palate cleft.
TP 8/60

	Deciduous	Permanent
	$\begin{array}{c} ** \\ \text{ed} / \text{bce} \\ \text{dc} / \text{c} \end{array}$	$\begin{array}{c} * \\ 1 / 6 \\ \hline 621 / 126 \\ * \end{array}$
CR	c // a a b c	3 // 1 1 2 3
MA		$\frac{2}{2} \text{ dens}$ invaginalis.

40. MMcD Male, b. 5/57. L. 9/57. P. 10/58.
Left lip alveolar palate cleft.
TP 5/61

Deciduous

Permanent

edcba / acde
e cba / abce

CR

c b a a // c

3 2 1 1 // 3

41. EMcG Male, b. 3/56. L. 6/56.
Left pre-alveolar cleft.
TP 11/60

Deciduous

Permanent

edcba / abbode
edcba / abode

CR

c b a a bM bD c

3 2 1 1 2 3

TA

/2

MA

bM central form
bD caniniform

/2 conical form

42. JMcJ Male, b. 8/49. L. 3/50. P. 5/52.
Left lip alveolar palate cleft.
TP 8/59

Deciduous

Permanent

64321 / 1 346
321 / 123 6
* *

CR

c b a a // bD c

3 2 1 1 // 3

43. JMcL Male, b. 1/52. L. 4/52. P. 8/53.
Left lip alveolar palate cleft.
TP 3/60

Deciduous

Permanent

dcb / abc
cb / d

6 / 6
61 / 1 6

CR

c b a a bM // bD c

3 2 1 1 // 3

OA

bM central form.
bD Group III form.

44. LM Female, b. 7/53. P. 12/55.
Post alveolar cleft.
TP 2/61

	Deciduous	Permanent
	*** edc / ede de **	* 6 / 6 6 / 6 *
CR	c b a a b c	3 1 1 3
TA		52/2 5/

(History of hyperglycaemia after birth can be related to the generalised enamel hyperplasia of the teeth.)

45. AM Female, b. 4/56. P. 2/58.
Post alveolar cleft.
TP 4/61

	Deciduous	Permanent
	cba / abc e cb / bc	6 / 6 61/1
CR	c b a a b c	3 2 1 1 2 3
TA		5/5 5/5
MA	/b Group IV form	/2 conical form /6 retarded calcification.

(Deciduous incisor form illustrated in Fig. 10 A)

46. RM Male, b. 9/54. L. 12/54. P. 8/56.
Bilateral lip right alveolar palate cleft.
TP 1/61

	Deciduous	Permanent
	* edca / abode edcba / abcde	6 / 6 6 / 6
CR	c // a a b c	3 // 1 1 2 3
MA	ba / geminated.	

47. AM Female, b. 1/52. L. 4/52. P. 9/53.
Left lip alveolar palate cleft.
TP 6/58

	Deciduous	Permanent
	$\frac{edcba}{edcba} / \frac{abede}{abede}$	
CR	c b a a // bD c	3 2 1 1 // 2D 3
MA	<u>/bD</u> Group III form	$\frac{2}{7}$ conical retarded calcification

48. JN Male, b. 6/48. L. 10/48. P. 1/50.
Bilateral lip alveolar palate cleft.
TP 2/57

	Deciduous	Permanent
	$\frac{edc/cde}{ba/ab}$	$\frac{6^{**} 1^{**}}{6/6}$
CR	c bD // bM a a bM // bD c	3 2D // 1 1 2M // 2D 3
TA		$\frac{5/5}{4/4.5}$
MA		<u>2D/2M</u> 2D conical forms.

(Absence of premolars illustrated in Fig. 16)

49. DN Male, b. 8/54. L. 12/54. P. 4/56.
Bilateral lip alveolar palate cleft.
TP 7/59

	Deciduous	Permanent
	$\frac{edc^* a^* / a^* cde}{edcba / abede}$	
CR	c // a a // c	3 2D // 1 1 // 2D 3
MA		Upper midline supernumerary present in perman- ent dentition.

50. JP. Male, b. 11/52. P. 7/54.
Post alveolar cleft.
TP 4/60

	Deciduous	Permanent
	$\frac{ec/bode}{edc/cd}$	$\frac{621/16}{621/126}$
CR	c b a a b c	3 2 1 1 2 3
TA		/5 absent.

51. DP Male, b. 6/56. L. 8/56. P. 11/57.
Left lip alveolar palate cleft.
TP 8/60

	Deciduous	Permanent
	$\frac{edcba/abode}{edcba/abode}$	
CR	c b a a // bD c	3 2 1 1 // 3
TA		/5 absent.

52. AP Male, b. 11/56. P. 7/58.
Post alveolar cleft.
TP 11/60

	Deciduous	Permanent
	$\frac{*edcba/abode}{edcba/abode}$ ****	
CR	c b a a b c	3 2 1 1 2 3

(History of severe fits after birth can be related to
generalised enamel hyperplasia of the teeth.)

53. DP Male, b. 1/54. L. 5/54. P. 8/55.
Bilateral lip alveolar palate cleft.
TP 3/60

	Deciduous	Permanent
	$\frac{dcb/bce}{dcb/bce}$	
CR	c bD // a a bM // bD c	3 // 11 // 2D 3
TA		/5
QA	$\frac{bM}{bD}$ central form caniniform.	/2D conical

54. AR Female, b. 7/53. L. 11/53. P. 1/55.
Right lip alveolar palate cleft.
TP 10/60.

	Deciduous	Permanent
	*** <u>edcba / abode</u> edcba / abode	<u>6 / 6</u> 6 / 6
CR	c bD // a a b c	3 // 1 1 2 3

55. DR Male, b. 8/56. L. 3/57. P. 1/58.
Left lip alveolar palate cleft.
TP 10/60.

	Deciduous	Permanent
	* <u>edcba / abode</u> edcba / abode	
CR	c b a a // bD c	3 2 1 1 // 2D 3
MA		/2 conical form.

56. JR Male, b. 3/55. L. 6/55.
Right lip and alveolar cleft.
TP 6/60

	Deciduous	Permanent
	<u>dcb a / abcd</u> cba / abc	
CR	c bD // a a b c	3 // 1 1 2 3

57. GR Male, b. 4/56. L. 3/57. P. 3/58.
Left lip alveolar palate cleft.
TP 12/60

	Deciduous	Permanent
	*** ** <u>dcb a / abbode</u> edcba / abcde	
CR	c b a a bM // bD c	3 2 1 1 // 3

58. ER Female, b. 4/54. P. 4/55.
Post alveolar cleft.
TP 7/60

Deciduous

Permanent

$\frac{edcba}{edcba} / \frac{abcde}{abcde}$

CR

c b a a b c

3 2 1 1 2 3

59. KR Female, b. 9/55. P. 11/57.
Post alveolar cleft.
TP 3/60

Deciduous

Permanent

$\frac{edcba}{edcba} / \frac{abcde}{abcde}$

CR.

c b a a b c

3 2 1 1 2 3

60. DS Male, b. 3/54. L. 6/54. P. 9/55.
Left lip alveolar palate cleft.
TP 11/58.

Deciduous

Permanent

$\frac{edcba}{edcba} / \frac{abcde}{abcde}$

CR

c b a a // bD c

3 2 1 1 // 2D 3

MA

/bD Group III form.

61. MS Female, b. 7/53. P. 11/55.
Post alveolar cleft.
TP 10/60

Deciduous

Permanent

$\frac{cba}{edc} / \frac{abc}{bce}$

$\frac{6}{621} / \frac{6}{126}$

CR

c b a a b c

3 2 1 1 2 3

TA

5/5 absent.

62. RS Male, b. 7/54. L. 3/55.
Right pre-alveolar cleft.
TP 1/61

	Deciduous	Permanent
	$\frac{edc}{dc} / \frac{bcde}{cde}$	$\frac{6^*1}{621} / \frac{16}{16}$
CR	c b a a b c	3 2D 2M 1 1 2 3
MA	b/ Group IV morphology	$\frac{2D}{2M}$ conical form with dens invaginalis.

63. TS Male, b. 12/53. L. 5/54. P. 7/55.
Left lip alveolar palate cleft.
TP 7/58.

	Deciduous	Permanent
	$\frac{edba}{edba} / \frac{a c}{abcde}$	
CR	c b a a // bD c	3 2 1 1 // 2D 3
MA	/bD Group IV form	/2D conical form

64. HS Male, b. 11/56. L. 2/57. P. 1/59.
Bilateral lip alveolar palate cleft.
TP 2/61

	Deciduous	Permanent
	$\frac{edcba}{edcba} / \frac{a^* cde}{abcde}$	
CR	c // bM a a // c	3 // 1 1 // 3

65. AS Male, b. 5/53. L. 9/53. P. 10/54.
Bilateral lip alveolar palate cleft.
TP 5/59

	Deciduous	Permanent
	$\frac{edcba}{e^* cba} / \frac{abb^* cde}{abcde^*}$	
CR	c bD // a a bM // bD c	3 // 1 1 // 2D 3

66. MS Female, b. 8/54. L. 12/54.
Right lip and alveolar cleft.
TP 7/60

	Deciduous	Permanent
	<u>edcba</u> / <u>abed</u> <u>edcba</u> / <u>abcd</u>	
CR	c bD // bM a a b c	3 2D // 2M 1 1 2 3
MA	<u>bM</u> / Group V form.	

67. SS Female, b. 1/56. L. 5/56. P. 7/58.
Right lip alveolar and palate cleft.
TP 6/60

	Deciduous	Permanent
	<u>edc a</u> / <u>abode</u> <u>edcba</u> / <u>abode</u>	
CR	c bD // a a b c	3 2 D // 1 1 2 3
TA		<u>5/5</u>
MA	<u>/d</u> paramolar cusp	<u>/2</u> conical form.

68. CS Male, b. 4/56. L. 2/57.
Left pre-alveolar cleft.
TP 3/61

	Deciduous	Permanent
	<u>edcba</u> / <u>abbode</u> <u>edcba</u> / <u>abode</u>	
CR	c b a a bM bD c	3 2 1 1 2M 2D 3.
TA		<u>5/</u>
MA	<u>/bM</u> Group III form	<u>/2D</u> conical form

69. RT Male, b. 7/54. L. 11/54. P. 1/56.
Right lip alveolar palate cleft.
TP 7/58

	Deciduous	Permanent
	<u>edca</u> / <u>abode</u> <u>edca</u> / <u>abode</u>	
CR	c // bM a a b c	3 // 1 1 2 3
TA		<u>5/5</u> <u>5/5</u>
MA	<u>bM</u> / central form	

70. MT Male, b. 5/56. P. 11/57.
Post alveolar cleft.
TP 11/60

	Deciduous	Permanent
	<u>edcba</u> / <u>abcde</u> <u>edcba</u> / <u>abcde</u> *** **	
CR	c b a a b c	3 2 1 1 2 3
TA		<u>5</u> / absent

71. CU Female, b. 8/54. L. 11/54.
Left lip and alveolar cleft.
TP 6/60

	Deciduous	Permanent
	<u>edcba</u> / <u>abcde</u> <u>cba</u> / <u>abc</u>	
CR	c b a a // bD c	3 2 1 1 // 3
TA		<u>5</u> / 5

72. PW Male, b. 2/57. P. 8/58.
Post alveolar cleft.
TP 4/61

	Deciduous	Permanent
	<u>edcba</u> / <u>abcde</u> <u>edcba</u> / <u>abcde</u>	
CR	c b a a b c	3 2 1 1 2 3
TA		<u>5</u> / <u>5</u> <u>5</u> / 5

73. KW Male, b. 11/55. L. 2/56. P. 4/57.
Left lip alveolar palate cleft.
TP 2/61

	Deciduous	Permanent
	<u>cba</u> / <u>abcde</u> <u>ecba</u> / <u>abc</u>	
CR	c b a a // bD c	3 2 1 1 // 3

74. GW Male, b. 2/53. L. 6/53. P. 8/54.
Bilateral lip alveolar palate cleft.
TP 9/58

	Deciduous	Permanent
	<u>edoba</u> / <u>abcde</u> <u>edcba</u> / <u>abcde</u>	
CR	c bD // a a // bD c	3 2D // 2M 1 1 // 2D 3
MA	<u>bD</u> / caniniform	<u>2D/2D</u> conical form.

75. LW Female, b. 5/54. P. 7/55.
Post alveolar cleft.
TP 7/60

	Deciduous	Permanent
	<u>edcba</u> / <u>abcde</u> <u>edcba</u> / <u>abcde</u>	
CR	c b a a b c	3 2 1 1 2 3

76. KW Female, b. 2/50. L. 7/50. P. 6/52.
Right lip alveolar palate cleft.
TP 12/59

	Deciduous	Permanent
	<u>edc/e</u>	<u>6 1</u> / <u>126</u> 621 / 126
CR	c bD // bM a a b c	3 2D // 2M 1 1 2 3
MA		<u>2D</u> / conical form.